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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 27177 and 27189.

26905 (CEA-N-1210) CHROMATOGRAPHY OF ACTINIDES ON ANION EXCHANGE PAPER. BEHAVIOR OF THE ELEMENTS U, Np, Pu, Am IN ACID, AQUEOUS AND ALCOHOL-WATER SOLUTIONS. Collin, Michel (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Feb 1970. 25p. (In French). Dep. CFSTI (U. S. Sales Only).

Actinide migration on ion exchange paper was studied first with trace amounts with a view to subsequent application in micro-analysis. The first tests made it possible to define the factors having an effect on the migrational velocities of the aqueous and the alcohol-water solutions of HCl and HNO_3. The behavior of the actinides was studied in nonsaline acid solutions. The results obtained for each element separately are interesting from the point of view of their mutual separation. (France)

26906 (LA-4407) LMFBR/FFTF FUEL DEVELOPMENT ANALYTICAL CHEMISTRY PROGRAM (PHASE II). Rein, James R.; Zeigler, R. Keith; Metz, Charles F. (Los Alamos Scientific Lab., N. Mex.). Mar 16, 1970. Contract W-7405-eng-36. 29p. Dep. CFSTI.

An evaluation of the adequacy of methods of analysis is presented for 13 chemical specifications of LMF BR-FF TF mixed uranium-plutonium oxide fuel. This evaluation is based on statistical analyses of the results obtained by seven laboratories on a distributed batch of FF TF fuel pellets and distributed special blends of certain impurities and a high purity uranium-plutonium oxide matrix. Recommended areas of improvement are given. (auth)

26907 (NBL-250) ANNUAL PROGRESS REPORT FOR THE PERIOD JULY 1968 THROUGH JUNE 1969. (New Brunswick Lab. (AEC), N. J.). Apr 1970. 64p. Dep. CFSTI.

Research progress is reported on: titrimetric determination of U; rapid separation of U by reversed-phase chromatography and determination by oxidimetric titration; recovery of U from phosphoric acid solution; determination of U after reduction in phosphoric acid by titration; x-ray spectrographic determination of U in U-Zr solutions; automatic determination of U with the Technicon Autoanalyzer; γ self-absorption coefficient in determination of ^{235}U in solids; controlled-potential coulometric determination of Pu; stability of plutonium sulfate tetrahydrate; determination of Pu by isotope dilution mass spectrometry; determination of U in Pu-U mixtures; determination of C in B and BC; preparation of boron-filled silicone elastomer; analysis of silicone elastomers; Getter system for impulse heater gloved box; computer-controlled isotope ratio mass spectrometer; symmetrical cylindrical rotating step sector; and a darkroom timer. (M.C.G.)

26908 (ORNL-tr-2305) CHEMICAL ANALYSIS OF OLD ART OBJECTS. Yamasaki, Kazuo. Translated for Oak Ridge National Lab., Tenn., from Jap. Anal.; 16: 1099-1103(1967). 14p. Dep. CFSTI.

Methods for analysis of old art objects (paintings, sculptures, and archeological finds) are discussed. Sampling procedures, spectroscopic analysis, x-ray fluorescence analysis, x-ray diffraction analysis, x-ray transmission analysis, uv spectroscopy, infrared spectra, and β scattering are considered. (M.C.G.)

26909 ANALYTICAL CHEMISTRY OF MOLYBDENUM. Busev, A. I. Analytical Chemistry of Elements. Ann Arbor, Mich.; Ann Arbor-Humphrey Science Publishers, Inc. (1969). 290p.

Translation of Analiticheskaya Khimiya Molibdena by J. Schmorak.

Topics covered include: chemical and analytical properties of Mo, detection, separation, and isolation, gravimetry, titration, photometry, and other methods for determination of Mo. (M.C.G.)

26910 ANALYTICAL CHEMISTRY OF ZIRCONIUM AND HAFNIUM. Elinson, S. V.; Petrov, K. I. Analytical Chemistry of Elements. Ann Arbor, Mich.; Ann Arbor-Humphrey Science Publishers, Inc. (1969). 251p.

Translation of Analiticheskaya Khimiya Tsirkoniya i Gafniya by N. Kaner.

Topics covered include: analytical description of Zr and Hf, methods for detection of Zr and Hf, separation of Zr and Hf from other elements and their gravimetric determination, titrimetric methods, photometry, polarography, radiometry, activation analysis, spectroscopic and x-ray methods, and analyses for impurities. (841 references) (M.C.G.)

26911 ANALYTICAL CHEMISTRY OF RUTHENIUM. Avtokratova, T. D. Analytical Chemistry of Elements. Ann Arbor, Mich.; Ann Arbor-Humphrey Science Publishers, Inc. (1969). 258p.

Translation of Analiticheskaya Khimiya Ruteniya.

An abstract of this book, prepared from the original language, appeared as NSA 17: 19986.

26912 ANALYTICAL CHEMISTRY IN SPACE. Wainerdi, R. E. (ed.). International Series of Monographs in Analytical Chemistry. Volume 35. Oxford; Pergamon Press (1970). 277p. £7.

A review is presented of analytical chemistry methodology applicable to performing meaningful measurements in the space environment, including the miniaturization of analytical experiments and their incorporation into space vehicles. A section is included on the analysis of lunar samples. A separate abstract was prepared for 4 of the seven sections of the book. (UK)

For abstracts of individual chapters see: 26913, 27008, 27025, and 28031.

26913 RECOVERED EXTRATERRESTRIAL MATERIAL. Napper, D.; Smales, A. A. (Atomic Energy Research Establishment, Harwell, Eng.). Int. Ser. Monogr. Anal. Chem.; 35: 209-75(1970).

A description is given of techniques applied to recovered meteoritic material and the potential application of these techniques to lunar material is discussed. Headings are as follows: nature of extraterrestrial material (meteorites; "cosmic" dust; tektites; lunar material); collection of extraterrestrial material; preparation of samples for analysis; dissolving of samples; general methods of analysis; activation analysis (sensitivity of activation method; determination of trace elements in meteorites; application to specific elements; radiochemical separation schemes for various elements; nondestructive analysis by γ-spectrometry; further reactor activation methods; other activation techniques-fast neutrons, etc.); mass spectrometry (isotope dilution; spark source mass spectrography); emission spectroscopy (sensitivity; instrumentation; excitation sources; samples and standards; use of laser microprobe; separation and solution techniques; applications to meteorites); flame photometry; atomic absorption spectroscopy; atomic fluorescence spectroscopy; x-ray fluorescence;

electron probe microanalysis; and Moessbauer spectroscopy. (471 references). (UK)

26914 ANALYTICAL CHEMISTRY. VOLUME 10. Stewart, D. C.; Elion, H. A. (eds.). Progress in Nuclear Energy. Series IX. Oxford; Pergamon Press (1970). 474p. 10 £.

This book is concerned entirely with the techniques of analytical chemistry behind shielding or in glove boxes. Separate abstracts are provided for 13 of the sections. An appendix gives a survey of world-wide shielded facilities, and a further appendix lists the more general references relating to remote manipulations with radioactive materials. (UK)

For abstracts of individual chapters see: 26915–26918, 26986–26992, 27098, and 27177.

26915 SAMPLING, SAMPLE DISSOLUTION, EVAPORATION, AND COMBUSTION. Lamb, C. E. (Oak Ridge National Lab., Tenn.). Progr. Nucl. Energy, Ser. IX; 10: 107–42(1970).

The subject is discussed under the following headings: safety; sampling (solids—drilling and coring, cutting and sawing, other machining techniques, electrolysis, crushing, blending; liquids; gases); dissolution (preparation of sample; techniques and equipment; chemical dissolution and leaching; electrolysis; fusion; sealed tube techniques; vapour removal); evaporation (techniques and equipment; hazards of volatile liquids); combustion (techniques and equipment). (100 references) (UK)

26916 EQUIPMENT AND TECHNIQUES FOR HANDLING LIQUID SAMPLES. Rickard, R. R. (Oak Ridge National Lab., Tenn.). Progr. Nucl. Energy, Ser. IX; 10: 143–79(1970).

A description is given of techniques employed for the remotely controlled transfer of samples of radioactive liquids, mixing of liquids, separation of solids from liquids, and distillation, under the following headings: intra-site transfer of radioactive samples (transfer through radiation barriers – port and drawer systems; rotating drum and cylinder systems, cask or carrier systems, special transfer systems; intercell transfer; intracell transfer – transfer of batches, dispensing liquids, jettison systems; cell-to-laboratory transfer); mixing of liquids (mechanical stirrers; magnetic stirrers; shaking); reaction vessels; liquid-solid separations (filtration; centrifugation); and distillation. Examples are given to illustrate these techniques. (114 references). (UK)

26917 ION EXCHANGE AND SOLVENT EXTRACTION. Morrow, R. J. (Univ. of California, Livermore). Progr. Nucl. Energy, Ser. IX; 10: 187–224(1970).

Solvent extraction and ion exchange techniques have proved almost indispensable for industrial scale processing of radioactive materials, as well as for smaller scale operations and the adaptation of solvent extraction to chromatography has extended the usefulness of this technique, particularly for multi-component separations. The most common analytical separation technique carried out in hot cells is single-stage solvent extraction, employing laboratory electromechanical mixers and screw-cap vials, together with "master-slave" type manipulators. Maintenance problems, danger of cross contamination, and a preference for simple, but effective, techniques have discouraged the development of automated extraction systems. It is emphasized that the radiation stability of ion exchange materials requires more study. Headings are as follows: solvent extraction (general; laboratory experience; radiolysis effects; monitoring of performance; extraction chromatography; mixer-settlers); ion exchange (general; laboratory experience; loading techniques; monitoring of elution; column heating and construction; fraction collectors; radiolysis effects); general assay problems; comparisons between ion exchange and solvent extraction; and facility design (automation; manual operation; manipulators). (95 references) (UK)

26918 ANALYTICAL CHEMISTRY IN GLOVE BOXES. Evans, H. B. (Argonne National Lab., Ill.). Progr. Nucl. Energy, Ser. IX; 10: 359–91(1970).

The topics covered are limited primarily to recent innovations, and emphasis is on materials which are highly toxic α-emitters. Fire and criticality are hazards that must be considered. Good housekeeping, ventilation, monitoring, and well-planned experimental procedures are details to be considered in avoiding trouble, and in this connection box accessories are important. It is considered that most commercially available glove boxes are too small; in many cases there is no provision for instrument containment. Topics covered include: experimental auxiliary equipment (heating methods and temperature control; vacuum systems; weighing equipment); sample preparation; methods of separation of materials (centrifugation; chromatography; diffusion; distillation; extraction; ion exchange; precipitation; pyrohydrolysis); analytical methods (optical – atomic absorption, spectrographic analysis, spectrophotometry; gas analysis; X-ray analysis-electron microprobe; calorimetry; electroanalytical methods – amperometry and polarography, conductometric methods, coulometric methods, electrolysis and electrodeposition, pH measurement and potentiometric titrations); physical measurements (density and viscosity; surface area and particle size; melting points); metallurgy; preparation and standardization of isotopic targets. Techniques and equipment were developed so that practically all of the available analytical tools can be used in handling highly radioactive materials under the limitations of glove box operation. Future emphasis will probably be on increased use of instrumental methods such as nuclear resonance, coulometry and atomic absorption, but further advances can be expected in the older techniques. (86 references) (UK)

Chemical and Spectral Procedures

26919 (AECL–3554) THE DETERMINATION OF COBALT BY CONTROLLED-POTENTIAL COULOMETRY. Durham, R. W.; Corriveau, V. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov 1969. 12p. Dep. CFSTI (U. S. Sales Only). AECL $0.50.

An analytical technique for determining cobalt by controlled-potential coulometric titration is described. A stationary gold electrode is used for oxidation and reduction in a supporting electrolyte containing 0.5% EDTA and 1.0% calcium acetate. Oxidation to Co (III) is carried out at +1.44 volts versus the saturated calomel electrode. This is followed by a pre-reduction at +0.34 volts and then the cobalt is determined by reducing from Co (III) to Co (II) at –0.38 volts. In the range from 1 to 2 mg of cobalt the standard deviation of a single result is ±0.2%. The method has been used to analyze 1% Co/Al neutron flux monitor wire and the results were compared with those obtained by other methods of analysis. (auth)

26920 (ANL–7668) DETERMINATION OF METALLIC IMPURITIES AT THE PPB-PPM LEVEL IN SODIUM. Ramachandra, T. P.; Hareland, W. A. (Argonne National Lab., Ill.). Mar 1970. Contract W-31-109-eng-38. 20p. Dep. CFSTI.

A rapid and reliable method was developed for separating and determining 13 trace metals in EBR-II sodium. Reactor sodium sampled in a high-purity tantalum cup is vacuum-distilled at 320°C in a quartz distillation unit, and the trace metals in the residue are subsequently determined by atomic absorption spectrophotometry. Of 15 metals tested, 13 remained quantitatively in the distillation residue, while zinc and cadmium as well as alkali metals distilled with the sodium. Recovery data are presented. Approximately 2 hr are required to distill 50 g of sodium in the distillation unit. Based on a 50-g sample, the following metals may be determined with a relative precision of ±25% at the levels indicated: aluminum, 600 ppB; bismuth, 100 ppB; calcium, 20 ppB; cobalt, 20 ppB; copper, 20 ppB; chromium, 20 ppB; iron, 50 ppB; magnesium, 5 ppB; manganese, 5 ppB; molybdenum, 70 ppB; nickel, 50 ppB; lead, 50 ppB; and tin, 500 ppB. The distillation residue is also suitable for gamma-spectrometric analysis of fission and activation products that do not distill with the sodium. (auth)

26921 (APDA–246) SAMPLING AND ANALYSIS FOR OXYGEN IN SODIUM. Deora, M. K.; Friedland, A. J.; Hunter, R. A.; Meyers, J. E. (Atomic Power Development Associates, Inc., Detroit, Mich.). Apr 1970. Contract AT(11-1)-865. 85p. Dep. CFSTI.

All of the research conducted at APDA in the area of sampling and analysis for oxygen in sodium is summarized. Pinched and nonpinched bypass freeze tube samplers were used in conjunction with the mercury amalgamation method for the determination of oxygen concentrations which ranged from 7 to 76 ppM. Temperature profiles of the sampling tubes during cooling were studied in an attempt to explain the axial segregation of oxygen. A detailed account is given of the experimental procedures as well as the statistical treatment and interpretation of results. (auth)

26922 (JUL–633–CA) APPARATUS ARRANGEMENT AND PROCEDURES FOR PREPARATION OF IRRADIATED AND UNIRRADIATED NUCLEAR FUEL SAMPLES FOR MASS SPECTROSCOPIC DETERMINATION OF URANIUM ISOTOPE RATIOS. Stoeppler, Markus (Kernforschungsanlage, Juelich (West Germany). Zentrallabor fuer Chemische Analyse). Dec 1969. 54p. (In German). Dep. CFSTI (U. S. Sales Only).

To obtain solutions of uranyl nitrate with high radiochemical and chemical purity for mass spectrometric determinations of isotopic ratios of uranium, apparatus and techniques for the processing of UO_2, UC_2, UO_2-ThO_2, and UC_2-ThC_2, etc., were developed. Remote dissolution and decontamination of these solutions with the aid of two simple glass devices for single samples or the simultaneous processing of up to eight samples are de-

scribed. Decontamination and purification steps for irradiated and inactive samples with the anion exchanger DOWEX 1 and by solvent extraction are explained and discussed. It is possible to obtain average decontamination factors for the uranium solution from $>10^4$ to $>10^9$ for thorium, iron, protactinium, and the most important fission products. The preparation and calibration of samples for mass spectrometric working conditions are discussed. The spectrophotometric and colorimetric procedures used for uranium and thorium and mixtures of both elements are described. (auth)

26923 (NIM-503) RAPID ESTIMATION, BY THE AMMONIUM THIOCYANATE METHOD, OF URANIUM IN RAFFINATE SOLUTIONS CONTAINING THORIUM, LEAD, AND COPPER. Laboratory Method No. 92/60. Cook, E. B. T.; Steele, T. W. (National Inst. for Metallurgy, Johannesburg (South Africa)). 29 May 1969. 4p. Dep. CFSTI (U. S. Sales Only).

A method applicable to solutions of as low a concentration of U as 0.05 g/l, and of as high a concentration of Th and HNO_3 as 100 and 160 g/l, respectively, is described. The pH value of the sample is adjusted to ~1.2, the ferric ion reduced by addition of $SnCl_2$ solution, and the uranium thiocyanate complex formed by addition of ammonium thiocyanate. The uranium content is then determined spectrophotometrically. (M.C.G.)

26924 ANALYTICAL METHODS IN THE PRODUCTION CONTROL OF FUEL OILS. Buncak, P. (VURUP, Bratislava). Ropa Uhlie; 10: 260-7(1968). (In Slovak).

Czechoslovak specifications for fuel oil and standard methods for determining various elements are discussed, and emission-spectrographic methods are described for the determination of V and Na by direct solution techniques. Flame photometry can be used to determine Na in the sample ash. Methods are indicated for determining H_2O, and also Mg or Si in samples to which corrosion inhibitors [containing $Mg(OH)_2$ or silica gel, respectively] have been added. (12 references) (Anal. Abstr.)

26925 CONDUCTIMETRIC DETERMINATION OF LANTHANUM AS METABORATE. Prasad, Sarju; Singh, Narayani Prasad (Banaras Hindu Univ., India). J. Inst. Chem. (India); 40: No. 3, 80-4(1968).

A conductimetric titration of La^{3+} (2 to 8 mg; ≃0.2 to 0.9 m<u>M</u>) against $NaBO_2$ (≃m<u>M</u> to 0.1 <u>M</u>) is described in which the reaction is quantitative and stoichiometric. Titrations were carried out in 15% ethanol with use of a conductivity bridge with dip cell for the measurement of conductance. (Anal. Abstr.)

26926 ISOTOPIC ANALYSIS OF TERRESTRIAL HELIUM ON A MAGNETIC RESONANCE MASS SPECTROMETER. Mamyrin, B. A.; Tolstikhin, I. N.; Anufriev, G. S.; Kamenskii, I. L. (Ioffe Inst. of Physics and Tech., Leningrad. Inst. of Precambrian Geology and Geochronology, Leningrad. All-Union Inst. of Petroleum Geology, Leningrad). Geochem. Int. (Engl. Transl.); 6: 517-24(1969).

Translated from Geokhimiya; No. 5, 595-602(May 1969).

A magnetic resonance mass spectrometer was constructed for isotopic investigations of natural He; its resolving power permits the complete separation of the lines of ^4He and (^3H + HD) from ^3He, even in the case of very small amounts of the latter. Analyses of He from various natural gases and some minerals show that the $^3He/^4He$ ratio ranges from 10^{-10} to 10^{-5}, its magnitude being in inverse proportional to the He content in gases. The authors suggest the possibility of He with a high ratio of isotopes in nature. (auth)

26927 EXTRACTION OF CHROMIUM(VI) WITH 4-METHYL-3-PENTENE-2-ONE AND SUBSEQUENT PHOTOMETRIC DETERMINATION AS DIPHENYLCARBAZIDE COMPLEX. Shinde, V. M.; Khopkar, S. M. (Indian Inst. of Tech., Bombay). Z. Anal. Chem.; 249: 239-41(6 Mar 1970).

A rapid and sensitive method was developed for the solvent extraction of chromium(VI) with mesityl oxide (indexed as 4-methyl-e-penten-2-one). Chromium(VI) is extracted with pure mesityl oxide from 1<u>M</u> HCl containing 2.5<u>M</u> KCl as the salting-out agent. The metal from the organic phase is stripped with dilute ammonia and determined photometrically as its diphenylcarbazide complex at 540 nm. Chromium(VI) can be extracted in presence of a large number of ions. Only 30 min are required for complete separation and determination. Average recovery was 98.6 ± 1.4%, the standard deviation ±1.3% (14.9 μg of Cr). (auth)

26928 USE OF THERMIONIC EMISSION IN ISOTOPE ANALYSIS OF LEAD AND LITHIUM. Levskii, L. K.; Murin, A. N.; Zaslavskii, V. G. (All-Union Geological Inst., Leningrad. Univ. of Leningrad). Geochem. Int. (Engl. Transl.); 6: 601-5 (1969).

Translated from Geokhimiya; No. 6, 751-6(Jun 1969).

Heating experiments using various silicate emitters show that the overwhelming bulk of Pb ions is produced by thermionic emission; contribution from surface ionization is negligible. Isotope analysis of Li utilizing thermionic emission procedures apparently yields good results (error ≤1% and reproducibility ~1%). (auth)

26929 BURNING OF REFRACTORY METALS BY INDUCTION HEATING WITHOUT FLUX FOR THE DETERMINATION OF CARBON. Friedrich, K.; Engelhardt, H. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). Z. Anal. Chem.; 249: 244-5(6 Mar 1970). (In German).

In the arrangement described, Nb, Ta, Mo, and W samples from 10 mg to 2 g could be burned. The influence of sample treatment on the carbon content of the crystals was studied. Carbon contents in the region below 10 ppM were determined. (M.C.G.)

26930 N-1,1'-(3,3'-DISULPHONATO-4,4'-BIPHENYLENE)-BIS-(3-N-HYDROXY-3-N-PHENYLTRIAZENE) AS A COLORIMETRIC REAGENT FOR Pd AND Mo. Krishnaswamy, N.; Bhargawa, H. D. (Indian Inst. of Tech., Bombay). Z. Anal. Chem.; 249: 241-4(6 Mar 1970).

N-1,1'-(3,3'-Disulfonato-4,4 -biphenylene)-bis-(3-N-hydroxy-3-N-phenyltriazene) was studied as spectrophotometric reagent for Pd and Mo. Instantaneous development of color, stability of the complexes over a wide range of pH, time, and temperature are some desirable qualities of the reagent. The tolerance of the reagent to the presence of neutral salts and other members of the Pt group metals is quite high. The absorbance measurements are carried out at 430 (Pd) and 420 nm (Mo). The standard deviation is 0.004 on the average (2 to 8 ppM Pd; 2 to 15 ppM Mo). (auth)

26931 ANALYSIS OF VERY SMALL QUANTITIES OF SUBSTANCES BY X-RAY FLUORESCENCE SPECTROMETRY. Schneider, Helga (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Z. Anal. Chem.; 249: 225-8(6 Mar 1970). (In German).

A maximum sample weight of 2 mg is melted in 1 g borax and the disk obtained is directly analyzed by x-ray fluorescence spectrometry. For a number of elements the limits of detection are given, and an example of the reproducibility of the method is given. Different examples of application are described and the results are presented. (auth)

26932 COULOMETRIC DETERMINATION OF MICRO-AMOUNTS OF HYDROGEN IN METAL. Yoshimori, Takayoshi; Ishiwari, Syuiti (Tokyo Univ.). Talanta; 17: 349-54(Apr 1970).

Hydrogen in metal was extracted into a carrier gas (argon) by heating at about 1100°C, and oxidized to water with copper(II) oxide. The water was converted into ammonia with sodium amide at 80°. The ammonia was then titrated with electrolytically generated hypobromite ion. The blank value of single determination could be reduced to less than 1 μg of water. Hydrogen in stainless steels, tantalum, and pure tin could be determined satisfactorily, and some results were compared with those obtained by the ordinary vacuum extraction method. (auth) (UK)

26933 DETERMINATION OF LOW CONCENTRATIONS OF ^{131}I IN FAST REACTOR COOLANT SYSTEMS. Ware, A. R.; Oldham, G.; Bibby, D. M. (Univ. of Tech., Loughborough, Eng.). Talanta; 17: 339-40(Apr 1970).

A method was devised for the determination of iodine-131 in the presence of mixed fission products in reactor coolants, by oxidation to elemental iodine followed by sublimation on to copper gauzes. The method reduces to a minimum contamination of the copper gauzes by ruthenium-103 and ruthenium-106 and eliminates contamination due to technetium-99 and cesium-137. It is possible to determine 10^2 cpm/ml from iodine-131 in a total count of 2×10^6 cpm/ml of fission products, with an accuracy of ±3%. The only activity collected on the copper gauzes was iodine-131 (62% collection efficiency) and ruthenium-103 (0.005% of total activity) which gave comparable count rates. The activity of these two isotopes was separated by single-channel gamma analysis. (auth) (UK)

26934 EFFECT OF VARIATIONS IN THE IRON AND CALCIUM CONTENTS ON THE ASH CONTENT DETERMINATION BY ABSORPTION METHODS USING 80 keV X-RAYS. Burek, Rudolf; Palica, Michal (Glowny Instytut Gornictwa, Katowice, Poland). Nukleonika; 14: 1011-18(1969). (In Polish).

The mass absorption coefficient of mineral matter in coal for 80-keV γ and x-rays depends mainly on the iron content. The remaining elements constitute a substance with a mass absorption coefficient independent of the variations in its chemical composition. The standard error in ash determination due to the variations in the iron content is 3.4%. (auth)

26935 COMPLEXIMETRIC DETERMINATION OF BISMUTH WITH EDTA IN TRICHLOROACETIC ACID MEDIUM WITH ARSENAZO III AS METALLOCHROMIC INDICATOR. Perez-Bustamante, J. A.; Alvarez Jimenez, D.; Burriel-Marti, F. (Univ., Madrid). Anal. Chim. Acta; 50: 354-7(May 1970).

Bismuth (III) and Arsenazo III form a highly colored complex species which exhibits the interesting property of being decomposed by EDTA in a trichloroacetic acid–sodium trichloroacetate medium (pH 1 to 2). Further investigation indicated that the reaction might prove most valuable for the complexiметric determination of Bi; in addition to the normal advantages shown by good complexiметric procedures, its unusual, for complexiметric methods, sensitivity makes the method attractive. Another good feature is that the end-point appears very clearly and instantaneously in the cold; the initial bluish color turns very sharply to red-crimson on addition of the stoichiometric amount of EDTA required by the formation of a 1:1 EDTA:Bi(III) complex. The procedure is described. Thus far only synthetic solutions have been analyzed. However, the remarkable simplicity, reproducibility, and accuracy found even at the 1- to 5-mg level of Bi make the method very attractive and versatile. (P.C.H.)

26936 CONTROLLED-POTENTIAL COULOMETRIC DETERMINATION OF THE OXYGEN–METAL RATIO IN MIXED URANIUM–PLUTONIUM OXIDES. Baerring, N. E.; Joensson, Guenther (Aktiebolaget Atomenergi, Studsvik, Sweden). Anal. Chim. Acta; 50: 229-36(May 1970).

A method has been developed for the determination of the oxygen–metal ratio in mixed oxides of uranium and plutonium. The sample is treated with hot concentrated phosphoric acid. Plutonium(IV), uranium(VI), total plutonium, and total uranium are then determined by controlled-potential coulometric procedures. The ratio is calculated from the equation: $O/M = 2 + [U(VI)] - 0.5[Pu(III)]/[U] + [Pu]$. (auth)

26937 SPECTROGRAPHIC METHOD FOR THE DETERMINATION OF RARE EARTHS IN PLUTONIUM: USE OF TRILAURYLAMINE. Dhumwad, R. K.; Joshi, M. V.; Patwardhan, A. B. (Bhabha Atomic Research Centre, Bombay). Anal. Chim. Acta; 50: 237-42(May 1970).

A spectrographic method for the estimation of some rare earths (Gd, Sm, Dy, Er, and Ce) in plutonium samples is described. The rare earths were separated from 100 mg of plutonium by extracting plutonium with trilaurylamine. After concentration of the solution, the spectrum was photographed on a Hilger large quartz spectrograph, with scandium as internal standard. The estimation ranges are Gd 10 to 100 ppM, Sm 50 to 300 ppM, Dy 5 to 100 ppM, Er 5 to 200 ppM, and Ce 100 to 600 ppM. The overall standard deviation is 14%. The method is applicable to samples containing calcium and iron up to 1000 ppM. The resolving power and line interferences are discussed. (auth)

26938 DETERMINATION OF TERBIUM(III) IN BORATE GLASSES. Reisfeld, Renata; Gur-Arieh, Z.; Greenberg, E. (Hebrew Univ., Jerusalem). Anal. Chim. Acta; 50: 249-54 (May 1970).

A procedure for the determination of terbium(III) in sodium borate–boric acid glasses is described. The emission and excitation spectra and the decay times are measured. The concentration dependence of the terbium(III) fluorescence can be described by two straight lines intersecting at 1% concentration. Concentrations in the ranges 0.001 to 1% (w/w) and 1 to 5% (w/w) can be determined. (auth)

26939 A DIRECT SPECTROPOLARIMETRIC DETERMINATION OF MAGNESIUM(II), CALCIUM(II), STRONTIUM(II), AND BARIUM(II) WITH D-(−)-trans-1,2-CYCLOHEXANEDIAMINETETRAACETIC ACID. Baker, J. R.; Pearson, K. H. (Texas A and M Univ., College Station). Anal. Chim. Acta; 50: 255-60 (May 1970).

A rapid titrimetric method was developed for magnesium(II), calcium(II), strontium(II), and barium(II), with the stereospecific ligand, D-(−)-trans-1,2-cyclohexanediaminetetraacetic acid (D(−)-CDTA), as titrant. A photoelectric polarimeter was used to monitor continuously the optical rotation of the solution during titration; the titrant and metal complexes formed are optically active and serve as self-indicators. The observed rotation is linear with respect to concentration of the metal complexes and D(−)CDTA, hence the end-point can be established by straight-line extrapolation. The most sensitive wavelength for spectropolarimetric analysis (365 nm) was determined from the optical rotatory dispersion curves. The range of average deviation from visual chelometry for the four metals titrated was 0.00 to 0.17%. (auth)

26940 DETERMINATION OF SILICON IN PLUTONIUM METAL BY DIFFERENTIAL LINEAR-SWEEP OSCILLOGRAPHIC POLAROGRAPHY. Plock, C. E.; Vasquez, J. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Anal. Chim. Acta; 50: 338-41(May 1970).

A polarographic method for the determination of Si in Pu metal, based on reduction of the yellow silicomolybdate complex in a citrate buffered medium at pH 1.5, is described. Twenty-two impurities commonly found in Pu metal were investigated to determine their effect on the Si determination. Methods for removing various impurities are mentioned. The effects of Pu on the determination of Si were examined by spiking Pu solutions with standard Si solutions. Fifteen solutions containing 0.5 to 1.0 g of Pu were spiked so that the final Si concentration ranged from 0.20 to 0.75 μg/ml. These solutions were taken through the sample preparation procedure and analyzed. The recovery ranged from 94.5 to 103.9% with an average of 99.4%. (P.C.H.)

26941 DETERMINATION OF AMMONIUM AND POTASSIUM IN PLUTONIUM(VI) SALTS BY AN ION EXCHANGE-TETRAPHENYLBORATE METHOD. Navratil, James D. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Anal. Chim. Acta; 50: 345-7(May 1970).

The determination of macro amounts (1 to 10%) of NH_4^+ and K^+ in polyplutonates was needed to determine the composition of two new plutonium salts. A combined ion exchange–tetraphenylboron method was therefore developed. The ammonium content in the ammonium-containing plutonyl salts usually averaged about 1%, hence 200- to 300-mg samples were the minimum possible. The K in the potassium plutonyl salts varied between 5 and 10%, and 100-mg cuts were usually made. For precision, five different aliquots of two plutonyl salts, containing NH_4 and K, respectively, were analyzed. The precision for the NH_4 and K contents were 7.51 and 1.20%, respectively. The analyses of the salts were in agreement with their reported stoichiometry. (P.C.H.)

26942 N-BENZOYL-o-TOLYLHYDROXYLAMINE AS A GRAVIMETRIC REAGENT FOR URANIUM(VI). Das, Mrinal K.; Majumdar, A. K. (Jadavpur Univ., Calcutta). Anal. Chim. Acta; 50: 243-7(May 1970).

N-Benzoly-o-tolylhydroxylamine has been used for the gravimetric determination of uranium(VI) by direct weighing of the complex. Uranium(VI) is precipitated quantitatively in the pH range 5.0 to 7.5 and its separation from a large number of metal ions is described. The composition of the complex has been formulated as $UO_2(C_{14}H_{12}O_2N)_2 \cdot C_{14}H_{13}O_2N$ in conformity with analysis, NMR, and mass spectra. The gravimetric factor for the conversion of the metal-complex to the metal is 0.2509, smaller than that for other reagents for uranium. (auth)

26943 MOESSBAUER SPECTROMETRY. DeVoe, J. R.; Spijkerman, J. J. (National Bureau of Standards, Washington, D. C.). Anal. Chem.; 42: No. 5, 366R-88R(Apr 1970).

Literature for 1968-69 is reviewed. Topics covered include: spectrometric techniques, experimental methods, computation methods, theoretical considerations, analytical applications, and correlations with other techniques. 737 references. (M.C.G.)

26944 INFRARED SPECTROMETRY. Crisler, R. O. (Procter and Gamble Co., Cincinnati). Anal. Chem.; 42: No. 5, 388R-97R(Apr 1970).

Literature for 1968-69 is reviewed. Topics covered include: techniques and instrumentation, computer-aided spectroscopy, interferometry, reflectance, analytical methods, and correlations and structure. (347 references.) (M.C.G.)

26945 EMISSION SPECTROMETRY. Margoshes, Marvin (Digilab, Inc., Silver Spring, Md.); Scribner, Bourdon F. Anal. Chem.; 42: No. 5, 398R-417R(Apr 1970).

Literature and developments for 1968-69 are reviewed. Topics covered include: spectral descriptions and classifications, instrumentation, standards and calibration, excitation sources, trace analysis, lasers and microanalysis, isotopic analysis, and other applications. 651 references. (M.C.G.)

26946 NUCLEAR MAGNETIC RESONANCE SPECTROMETRY. Heeschen, Jerry P. (Dow Chemical Co., Midland, Mich.). Anal. Chem.; 42: No. 5, 418R-51R(Apr 1970).

Developments and literature from July, 1967 to July, 1969 are reviewed. Topics covered include: instrumentation, experimental techniques, high resolution techniques, relaxation and basic phenomena, chemical shift and coupling, kinetic processes, conformation and configuration, association phenomena, and other topics. 1149 references. (M.C.G.)

26947 ELECTROANALYSIS AND COULOMETRIC ANALYSIS. Bard, Allen J. (Univ. of Texas, Austin). Anal. Chem.; 42: No. 5, 22R-32R(Apr 1970).

The literature and developments during 1968 through December 1969 are reviewed. Topics covered include: electroseparations

and electrogravimetry, controlled potential coulometry, controlled current coulometry, and apparatus. 307 references. (M.C.G.)

26948 ELECTROPHORESIS. Strickland, R. D. (Veterans Administration Hospital, Albuquerque, N. Mex.). Anal. Chem.; 42: No. 5, 32R-57R(Apr 1970).

Developments and literature between the latter part of 1967 and the first half of 1969 are reviewed. Topics covered include: fundamental developments, apparatus, stabilizing media, buffers and solvents, biological applications, and general chemical applications. (1421 references). (M.C.G.)

26949 FLUOROMETRIC ANALYSIS. White, Charles E. (Univ. of Maryland, College Park); Weissler, Alfred. Anal. Chem.; 42: No. 5, 57R-76R(Apr 1970).

Developments and literature in the period from December 1967 to December 1969 are reviewed. Topics covered include apparatus, fluorescence analysis of inorganic substances, and fluorometry of organic and biological materials. (763 references). (M.C.G.)

26950 ION EXCHANGE. Walton, Harold F. (Univ. of Colorado, Boulder). Anal. Chem.; 42: No. 5, 86R-99R(Apr 1970).

Reviews are presented on ion exchange and ion exchange chromatography for 1968 and 1969. Topics covered include: theory, techniques, new and special exchanging materials, nonchromatographic applications, complex ion studies, inorganic applications, organic applications, paper and thin-layer chromatography, and liquid ion exchangers. (529 references). (M.C.G.)

26951 INORGANIC ANALYSIS. West, Philip W. (Louisiana State Univ., Baton Rouge); West, Foymae K. Anal. Chem.; 42: No. 5, 99R-104R(Apr 1970).

The development of analytical methods for inorganic analysis is reviewed. Topics covered include: optical methods, electroanalytical methods, standards and reagents, separations, masking, catalysis, amplification methods, and ternary complexes. (145 references) (M.C.G.)

26952 ORGANIC ELEMENTAL ANALYSIS. Ma, T. S. (City Univ. of New York, Brooklyn); Gutterson, Milton. Anal. Chem.; 42: No. 5, 105R-14R(Apr 1970).

Developments in the quantitative determination of elements in organic compounds and materials from October 1967 through September 1969 are reviewed. Topics covered include: carbon and hydrogen, nitrogen, oxygen, halogens, sulfur, selenium, phosphorus, arsenic, organometallics, simultaneous determination of several elements, submilligram samples, and trace analysis. (260 references) (M.C.G.)

26953 CHEMICAL MICROSCOPY. Cocks, George G. (Cornell Univ., Ithaca, N. Y.). Anal. Chem.; 42: No. 5, 114R-23R(Apr 1970).

Articles and books of potential interest to those who use the microscope to solve chemical problems are reviewed. Topics covered include: optics, instruments and equipment, polarized light microscopy, infrared and ultraviolet light microscopy, phase contrast microscopy, interference microscopy, wavefront reconstruction microscopy, fluorescence microscopy, schlieren microscopy, microphotometry and microspectrophotometry, darkfield and ultramicroscopy, techniques for specimen preparation, techniques for specimen examination, applications, and analytical microscopy. (214 references) (M.C.G.)

26954 POLAROGRAPHIC THEORY, INSTRUMENTATION, AND METHODOLOGY. Nicholson, Richard S. (Michigan State Univ., East Lansing). Anal. Chem.; 42: No. 5, 130R-8R(Apr 1970).

Developments and literature from January 1968 to approximately December 1969 are reviewed. Topics covered include: classical polarography, chronopotentiometry, a-c polarography, chronoamperometry, inverse polarography, disk and ring-disk voltammetry, diverse electrode systems, and photopolarography. (233 references) (M.C.G.)

26955 LIGHT ABSORPTION SPECTROMETRY. Boltz, D. F. (Wayne State Univ., Detroit); Mellon, M. G. Anal. Chem.; 42: No. 5, 152R-68R(Apr 1970).

The progress on analytical absorption spectrometry of the visible region of the spectrum is reviewed for the period November 1967 through November 1969. Topics covered include: chemistry, physics, applications, and conclusions. Tables of photometric methods for metals are given. (647 references) (M.C.G.)

26956 MASS SPECTROMETRY. DeJongh, D. C. (Wayne State Univ., Detroit). Anal. Chem.; 42: No. 5, 169R-205R(Apr 1970).

Developments and literature in 1968-69 are reviewed. Topics covered include: theoretical studies, ion structure and fragmentation mechanisms, organic compounds, natural products and biomedical research, mass spectra of inorganic compounds, spark source mass spectrometry, analysis, isotopic ratio measurements and geo- and cosmo-applications, combined gas chromatography-mass spectrometry, multiply charged and metastable ions, ion cyclotrpn resonance spectroscopy, ion–molecule reactions, ionization, data handling, and instrumentation. (1696 references) (M.C.G.)

26957 RAMAN SPECTROMETRY. Hester, Ronald E. (Univ. of York, Eng.). Anal. Chem.; 42: No. 5, 231R-9R(Apr 1970).

The literature between late 1967 and late 1969 is reviewed. Topics covered include: experimental technique, theoretical advances, solid state, gases, inorganic compounds, organometallic compounds, organic compounds, polymers, and electronic, stimulated, hyper, and inverse effects. (422 references) (M.C.G.)

26958 ULTRAVIOLET SPECTROMETRY. Crummett, Warren; Hummel, Richard (Dow Chemical Co., Midland, Mich.). Anal. Chem.; 42: No. 5, 239R-48R(Apr 1970).

Literature covering the period from December 1967 to December 1969 is reviewed. Topics covered include: apparatus, spectral studies of classes of compounds, adsorbed molecules and crystals, vacuum ultraviolet spectral data, effects of temperature and pH, solution equilibria, reaction mechanisms, reaction rates, theory and calculations, elucidation of structure, complexes, inorganic analysis, organic analysis, and biological and pharmaceutical analysis. (412 references) (M.C.G.)

26959 X-RAY ABSORPTION AND EMISSION. Campbell, William J. (Bureau of Mines, College Park, Md.); Gilfrich, John V. Anal. Chem.; 42: No. 5, 248R-68R(Apr 1970).

Developments in 1968-69 on x-ray absorption and emission analysis are reviewed. Topics covered include: x-ray spectrography, instrumentation, applications, energy dispersion x-ray analysis using radioactive isotopic sources, low-energy x-rays, electron probe microanalysis, quantitative analysis, instrumentation and techniques, and applications. (546 references) (M.C.G.)

26960 THERMAL ANALYSIS. Murphy, C. B. (Xerox Corp., Rochester, N. Y.). Anal. Chem.; 42: No. 5, 268R-76R(Apr 1970).

Major trends in thermal analysis in 1968-69 are reviewed. Topics covered include: differential thermal analysis, thermogravimetric analysis, pyrolysis, electrothermal analysis, microscopy, and dilatometry. (300 references) (M.C.G.)

26961 AMPEROMETRIC TITRATIONS. Stock, John T. (Univ. of Connecticut, Storrs). Anal. Chem.; 42: No. 5, 276R-84R(Apr 1970).

Developments and literature are reviewed for 1968-69. Topics covered include: apparatus and methodology, acid-base reactions, and oxidation-reduction reactions. (317 references) (M.C.G.)

26962 POTENTIOMETRIC TITRATIONS. Toren, E. Clifford Jr. (Duke Univ., Durham, N. C.); Gross, Paul M.; Buck, Richard P. Anal. Chem.; 42: No. 5, 284R-304R(Apr 1970).

Developments and literature in the area of potentiometric titrations and electrodes are reviewed for 1968-69. Topics covered include: titration curves and equilibrium calculations, electrodes, nonaqueous titrimetry, techniques, apparatus, and applications. (927 references) (M.C.G.)

26963 MAGNETIC SUSCEPTIBILITY. ASPECTS OF INSTRUMENTATION AND APPLICATIONS INCLUDING LUNAR STUDIES. Mulay, L. N.; Mulay, Indumati L. (Pennsylvania State Univ., University Park). Anal. Chem.; 42: No. 5, 325R-33R(Apr 1970).

Some selected aspects of instrumentation and applications to chemistry including the solid state covering the literature for 1968-69 are reviewed. Topics covered include: error analysis for classical methods, modifications of Faraday balance, torque magnetometers for anisotropy measurements, vibrating sample magnetometers, resonance and inductance techniques, temperature control, magnetic studies on lunar samples, intramolecular antiferromagnetism, superparamagnetism, diamagnetic anisotropy, and chemical equilibrium. (89 references) (M.C.G.)

26964 CHROMATOGRAPHY. Zweig, Gunter (Syracuse University Research Corp., N. Y.); Moore, Richard B.; Sherma, Joseph. Anal. Chem.; 42: No. 5, 349R-62R(Apr 1970).

Developments and literature in 1968-69 on liquid column chromatography (excluding ion exchange), paper chromatography, and thin-layer chromatography are reviewed. General considerations and theory, techniques, and uses are discussed. (487 references) (M.C.G.)

26965 CONDUCTIMETRIC DETERMINATION OF BARIUM, STRONTIUM, COPPER, OR ZINC WITH CITRATE. II. Bosch-

Reig, F.; Burriel-Marti, F. (Univ., Madrid). Inform. Quim. Anal., Pura Apl. Ind.; 22: 207-14(1968). (In Spanish).

The conductimetric titration of Ba, Sr, Cu(II) or Zn with citric acid neutralized to varying extents with triethanolamine or NaOH was investigated. Satisfactory results for each metal were obtained by using citric acid fully neutralized with triethanolamine. Full neutralization with NaOH was satisfactory in some instances, but two-thirds neutralization of the citric acid with either base was unsatisfactory. (Anal. Abstr.)

26966 SIMULTANEOUS POTENTIOMETRIC DETERMINATION OF FREE ACID AND ALUMINUM IN IRRADIATED MODERATED THERMAL REACTOR FUELS. Guillen Glaban, J. M. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B; 64: 931-6(1968). (In Spanish).

The method was applied to solutions that were 1 M in free HNO_3 and contained 7.5 to 11.2 g of U/l, 32 to 49 g of Al/l, and ≈15 C/l of γ activity. The solution was titrated potentiometrically with 0.05 M KOH and a glass electrode in the presence of K oxalate solution of pH 10.5 as chelating agent for Al and U. Two peaks were obtained; the first corresponded to neutralization of the acid and the second to the formation of AlO_2^-. The method is rapid, but the error may be as large as 5%. (Anal. Abstr.)

26967 USE OF DIFFERENCE SPECTROPHOTOMETRY IN THE DETERMINATION OF YTTRIUM IN TOTAL RARE-EARTH METALS. Ganopol'skii, V. I. Vestsi Akad. Navuk BSSR, Ser. Khim. Navuk; No. 2, 39-44(1968). (In Belorussian).

A proposed method for the determination of Y in rare earth metals is based on the difference in atomic weights and similarity of molar extinction coefficients of their complexes with Arsenazo I (I) and Arsenazo III (II). Solutions of Y_2O_3 and mixed rare earth oxides of concentrations of 100 μg/ml (as oxides) are used for construction of a calibration graph. A standard series of solutions is prepared from different volumes of the solution of Y_2O_3 and rare earth oxides with the total volume of each solution being 5 ml (500 μg of oxides of Y and rare earth metals). Five ml of a borate buffer solution of pH 7.09 and 5 ml of a 0.15% solution of I are added to each rare earth solution, the solutions are diluted to 50 ml, and the extinction of each solution is measured at 570 nm against a solution containing in 50 ml 250 μg of rare earth oxides and 250 μg of Y_2O_3 and the above amounts of reagents. With >250 μg of rare earth oxides, the relative extinction is negative. The calibration graph (extinction vs % Y_2O_3) is rectilinear. For the determination of Y_2O_3 in rare earth oxides, 200 mg of the sample (not containing other metals) is dissolved in 5 ml of HCl (1 : 1), the solution is evaporated almost to dryness, and the residue is dissolved in H_2O diluted to 100 ml. Five ml of this solution is treated as described for the calibration graph. Because the color reaction of the rare earth metals and Y with II is more sensitive than with I, if II is used as a reagent, the total concentration of rare earth oxides and Y_2O_3 in the final solutions is reduced to 4 μg/ml; and the extinction is measured at 655 nm. With either reagent the error is ±16% for 5% Y_2O_3 and ≈7.5% for 12% Y_2O_3. (Referativnyi Zh.)

26968 BURNUP DETERMINATION OF NUCLEAR FUEL. Inoue, Kiyoshi; Taniguchi, Kaoru (Hitachi Ltd., Tokyo). Shitsuryo Bunseki; 17: 830-42(Dec 1969).

A general description of burnup determining experiments is presented for illustrating a part of mass spectrometry. A comparison of results obtained from radiochemical and nondestructive analyses is presented. The specimen of nuclear fuel was grains of uranium dioxide irradiated in a nuclear reactor for about 200 days, and its burnup was found to be 8,000 MWd/t with sufficient consistency in the experimental results. (auth) (NSA of Japan)

26969 DETERMINATION OF NITROGEN IN ZIRCONIUM AND NIOBIUM NITRIDES. Selezneva, N. A.; Plotnikova, O. M. Izv. Akad. Nauk Kaz. SSR, Ser. Khim.; No. 6, 80-2(1968). (In Russian).

A 20- to 80-g sample of the nitride is heated to fumes in a Kjeldahl flask with 2 to 3 ml of concentrated H_2SO_4. Then 0.5- to 1-ml portions of H_2O_2 are added to completely decompose the sample. The resulting solution is diluted to 100 ml, and to 5 to 20 ml of this solution in a distillation flask is added 7 to 10 ml of 33% NaOH solution. The NH_3 is distilled into a flask containing 25 ml of 0.01 N H_2SO_4, and the unconsumed H_2SO_4 is titrated with 0.01 N NaOH to a color change from red to green of a 1 : 4 mixture of methylene blue and methyl red as indicator. The error is ≈±0.3%. (Referativnyi Zh.)

26970 POLAROGRAPHIC DETERMINATION OF VITAMIN D_2 [ERGOCALCIFEROL] IN ERGOSTEROL IRRADIATION PRODUCTS. Bogoslovskii, N. A.; Mairanovskii, V. G.; Kuznetsova, E. N. Khim.-Farm. Zh.; 2: No. 5, 39-42(1968). (In Russian).

A polarographic method was developed for determining ergocalciferol (I) in ergosterol irradiation products, of which precalciferol (II) and tachysterol (III) are polarographically active. The polarographic waves due to I and II are separated by derivative polarography. A method is proposed for removing III (which interferes in the determination of I), based on the rapid photooxidation of III by means of oxygen in the presence of a photosensitizer; I and II are not oxidized. To 5 ml of an ethanolic sample (containing 0.2 to 2 mg of I and II/ml) 0.05 to 0.4 ml of 0.001 M ethanolic methylene blue is added; O (5 to 10 ml/min) is passed through the sample, and the solution is irradiated with a 10-W incandescent lamp. One ml of the resulting solution is transferred to a polarographic cell, 5 ml of 0.04 M tetraethylammonium salt in dimethylformamide is added, and the derivative polarogram from 1.4 V (vs an internal Ag anode) is recorded. The concentrations of I and II are found from a calibration graph, and the error in determining I in mixtures is <±3.5%. (Referativnyi Zh.)

26971 GAS CHROMATOGRAPHY. Juvet, Richard S. Jr. (Univ. of Illinois, Urbana); Cram, Stuart P. Anal. Chem.; 42: No. 5, 1R-22R(Apr 1970).

Developments in the field of gas chromatography for the years 1968-69 are surveyed. Topics covered include: packed columns, open tubular columns, detectors, quantitative analysis and instrumentation interfacing, and specialized operations. (742 references). (M.C.G.)

26972 FLAME SPECTROMETRY. Winefordner, J. D. (Univ. of Florida, Gainesville); Vickers, T. J. Anal. Chem.; 42: No. 5, 206R-31R(Apr 1970).

Developments and literature in 1968 and 1969 are reviewed. Topics covered include: fundamental studies, atomic and molecular emission spectrometry, atomic absorption spectrometry, and atomic fluorescence spectrometry. (569 references). (M.C.G.)

26973 USE OF EXTRACTION FOR PRODUCTION OF SAMPLES FOR CONDUCTOMETRIC ANALYSIS OF HEAVY WATER. Cabicar, J. (Technische Hochschule, Prague); Kudlacek, R.; Jedinakova, V. Collect. Czech. Chem. Commun.; 35: 675-9 (Feb 1970). (In German).

The concentration of heavy water in a solution of a weak acid could be determined by the difference in conductivity of the H_3O^+ and D_3O^+ ions. To prepare samples for the study, redistilled, analytically pure benzene, propionic acid, and water with known deuterium contents were used. Data are presented in graphs. In the region of medium and high concentrations, D_2O contents could be determined with an accuracy of ±0.1%. (M.C.G.)

26974 QUANTITATIVE GAS-CHROMATOGRAPHIC ANALYSIS OF THE HYDROGEN ISOTOPES H_2, HD, D_2 ON ETCHED GLASS. Gaeumann, T.; Piringer, O.; Weber, A. (Institut de Chimie Physique, Lausanne, Switzerland). Chimia (Aarau); 24: 112-13 (16 Mar 1970). (In German).

A fast, quantitative routine determination of the isotope molecules H_2, HD, and D_2 with a conventional gas chromatographic apparatus is described. The column was filled with alkaline-etched and Fe_2O_3-impregnated glass powder or beads of 0.09 to 0.12 mm diameter. After activation at 300°C, a complete separation of HD/D_2 in 2 minutes at 77°K was obtained using H_2 as carrier gas with a flow rate of 75 ml/min. With a catharometer as detector and 0.5 ml samples of H_2, HD, and D_2-mixtures, analysis in the concentration range between 0.05 to 100% of D is possible. (auth)

26975 BARIUM AND STRONTIUM DETERMINATION IN BIOLOGICAL MATERIALS BY ATOMIC ABSORPTION SPECTROSCOPY. Miro, Milagros; Sutton, Doris C. (Atomic Energy Commission, New York). Appl. Spectrosc.; 24: 220-5(Mar-Apr 1970).

Ashed samples of diet, excreta, soft tissue, and bone were measured for trace amounts of stable barium and strontium by atomic absorption spectroscopy after classical chemical separation and anion exchange chromatography. Barium, strontium, and calcium were separated from silica by dehydration, the alkali metals by phosphate collection, and magnesium, the transition metals, and phosphate by nitrate precipitation. Barium was separated from strontium and calcium by absorption on Bio-Rad AG 1-X8 (100 to 200 mesh) anion exchange resin in methanol–nitric acid mixed solvent. Barium-133 and strontium-85 tracers were added to the samples to correct radiometrically for losses during the chemical method. Atomic absorption measurements for barium and strontium were made at the resonance lines of 5536 and 4607 Å, with nitrous oxide–acetylene and air–acetylene flames, respectively. Radiometric yields of barium-133 and strontium-85 ranged between 85 to 95% and 75 to 99%, respectively, with an average coefficient of variation of 5 to 6%. (auth)

26976 THE DETERMINATION OF THORIUM IN RARE EARTHS BY GAMMA-RAY SPECTROMETRY. Persiani, C.; Cosgrove, J. F. (General Telephone and Electronics Labs. Inc., Bayside, N. Y.). Appl. Spectrosc.; 24: 250-2(Mar-Apr 1970).

A method for the radiometric nondestructive determination of thorium in rare earths using multichannel gamma-ray spectrometry is described. Radioactive secular equilibrium is discussed relative to the method. Results obtained are compared to other analytical techniques. (auth)

26977 QUANTITATIVE DIRECT-CURRENT ARC ANALYSIS OF RANDOM COMPOSITIONS OF MICROGRAM RESIDUES IN SILVER CHLORIDE COMMON MATRIX. Gordon, William A.; Chapman, Gilbert B. (Lewis Research Center, Cleveland). Spectrochim. Acta, Part B; 25: 123-37(Mar 1970).

A spectrochemical procedure is described for quantitatively determining random combinations of 20 programmed elements: Al, Co, Cr, Fe, Hf, Mn, Mo, Nb, Ni, Pd, Re, Si, Ta, Ti, Th, U, V, W, Y, and Zr. The response of a direct-reading spectrometer was calibrated for absolute amounts of each of these elements alone over the range from 0.01 to 10 μg. Absolute amounts of elements in the sample were determined from these calibration curves, with correction made for background and spectral line interferences. Percentage compositions are calculated from the absolute amounts of analyte elements determined. Analysis of some alloy standards with and without use of a comparison standard are reported as examples of results attainable by the procedure. With automation of sample arcings and data reduction, the analysis time is about four minutes per sample, including preparation of electrodes through data recording, but not including sample dissolution. (auth) (UK)

26978 SPECTROPHOTOMETRIC DETERMINATION OF IRON(III) BY SOLVENT EXTRACTION OF IRON(III)-INDOFERRON CHELATE. Wakamatsu, Yoshinobu (Hachinohe Technical Coll., Japan); Otomo, Makoto. Jap. Anal.; 19: 537-41(Apr 1970). (In Japanese).

A new, sensitive method is described for the spectrophotometric determination of iron(III). It is based on the extraction of the iron(III)–indoferron chelate into chloroform in the presence of 1,3-diphenylguanidine. The extracted species shows an absorption maximum at about 635 mμ, having the composition of 1:2:2 in metal–ligand–amine ratio. An addition of sodium chloride is effective for complete extraction of the chelate. Under optimum conditions, a linear relationship between absorbance of organic phase and iron(III) content of aqueous phase is obtained in the range from 3.1 to 19.5 μg Fe(III) per 20.0 ml. The sensitivity of the reaction is 0.003 μg Fe(III) per cm^2. Titanium(IV), thorium(IV), vanadium(IV), and chelating agents such as NTA, EDTA, and CyDTA interfere with the determination. (auth)

26979 SEPARATION OF MICROGRAM QUANTITIES OF THORIUM AND URANIUM BY TTA EXTRACTION; SPECTROPHOTOMETRIC DETERMINATION WITH ARSENAZO III. Onishi, Hiroshi; Sekine, Keiichi (Japan Atomic Energy Research Inst., Ibaraki). Jap. Anal.; 19: 547-50(Apr 1970). (In Japanese).

A method was developed for the separation and determination of microgram quantities of thorium and uranium(VI). Thorium is extracted with 0.15M TTA (thenoyltrifluoroacetone) in benzene at pH 1.0. Uranium remains in the aqueous phase. Thorium and uranium are then determined spectrophotometrically with Arsenazo III. In the presence of oxalic acid (0.1 g per 25 ml of aqueous phase), thorium can be separated from uranium by extraction with TTA at pH 5.5. Repeated analyses of samples containing 10 μg of thorium and 20 μg of uranium gave average recoveries of 94% for thorium (relative standard deviation was 1.2%) and 100% for uranium (1.5%). In the presence of oxalic acid, average recoveries were 97% for thorium (1.5%) and 94% for uranium (2.4%). (auth)

26980 SPECTROPHOTOMETRIC DETERMINATION OF TIN (IV) WITH GALLEIN AND CETYLPYRIDINIUM BROMIDE. Mori, Itsuo (Osaka Coll. of Pharmacy). Jap. Anal.; 19: 455-8(Apr 1970). (In Japanese).

Tin(IV) reacted with gallein in the presence of an excessive cetylpyridinium bromide (CPB) at pH < 2.0 to form a water-soluble red complex. By the addition of CPB, the reagent blank of gallein decreased and the sensitivity for the determination of tin increased. To the solution containing 0 to 20 μg of Sn(IV) were added 2 ml of 1.0×10^{-2}M CPB and 1.0×10^{-3}M gallein, and the solution was made up to 10.0 ml and pH < 2.0 with 3% sulfuric acid and water. After 60 min standing at 15°C, the absorbance at 530 mμ was measured against the reagent blank. Bi(III), Sb(III), Th(IV), Zr(IV), Fe(III), and Al(III) interfered seriously. (auth)

26981 DETERMINATION OF NEODYMIUM, SAMARIUM, AND EUROPIUM AS IMPURITIES IN LANTHANUM OXIDE BY A LUMINESCENCE METHOD. Poluektov, N. S.; Smirdova, N. I.; Efryushina, N. P. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 25: 715-18(Apr 1970). (In Russian).

A luminescence method has been developed for determining neodymium, samarium, and europium in lanthanum oxide of high purity by recording the fluorescence spectra of crystal phosphors based on lanthanum oxychloride. The sensitivity of the method is $n \times 10^{-5}$ to $n \times 10^{-4}$%. (auth)

26982 ON THE POLAROGRAPHIC ANALYSIS OF SOME MIXTURES OF THE RARE EARTH ELEMENTS. Sevryukov, N. N.; Dorofeeva, G. I.; De-Sil'va, L. (Patrice Lumumba Univ. of People's Friendship, Moscow). Zh. Anal. Khim.; 25: 695-9(Apr 1970). (In Russian).

Studies were made on the possibility of the indirect polarographic determination of individual rare earths and their total content using manganese which is displaced by them from Mn $EDTA^{2-}$. The heavy rare earth elements can be determined in the presence of lanthanum and other light rare earths by means of the complexes of other readily polarographed metals with EDTA. (auth)

26983 SPECTROGRAPHIC ANALYSIS OF BINARY ALLOYS. I. ANALYSIS OF ZIRCONIUM AND HAFNIUM ALLOYS. Korneev, V. A.; Barinov, I. P.; Isaeva, O. G. Zh. Anal. Khim.; 25: 732-6(Apr 1970). (In Russian).

Methods are suggested for the direct quantitative spectrographic analysis of zirconium–hafnium alloys. Spectra were excited in a high-frequency spark (a copper electrode) and photographed on a DFS-8 spectrograph (dispersion 3 A/mm) with a three-lens system of slit illumination. The analysis of one sample by two spectra takes about 30 min, the analysis of 20 samples takes about 3 hours. (auth)

26984 PHOTOMETRIC DETERMINATION OF NIOBIUM BY MEANS OF 1-(2-PYRIDYLAZO)-RESORCINOL. Kuchmistaya, G. I.; Dobkina, B. M.; Elinson, S. V. (State Scientific-Research and Design Inst. of Rare Metal Industry, Moscow). Zh. Anal. Khim.; 25: 742-5(Apr 1970). (In Russian).

A complex compound niobium tartrate with 1-(2-pyridylazo) resorcinol was studied in a strongly acid (1 N) solution. Due to the different ionic states of the reagent in a strong acid and in a weak acid (pH 5 to 6) solution the niobium complex compounds formed differ in their maximum absorption and composition. A method was developed for determining more than 0.01% of niobium in ores by this method. (auth)

26985 TIPYROGIN: A NEW COLORLESS REAGENT FOR THE PHOTOMETRIC DETERMINATION OF NIOBIUM. Basargin, N. N.; Yakovlev, P. Ya.; Panarina, N. A. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Zh. Anal. Khim.; 25: 746-51(Apr 1970). (In Russian).

Tipyrogin [N-methyl-N,N-bis(methylenepyrogallol)amine] is suggested for the photometric determination of niobium. This reagent is more sensitive and interacts in more acid media than other colorless reagents. It forms a yellow soluble complex with niobium(V) in a medium of 0.25 to 0.5 N HCl. The molar extinction coefficient in 0.3 N HCl at 385 nm and the reagent concentration of $1.5 \cdot 10^{-2}$ M is $1.48 \cdot 10^4$. No interference to niobium determination in the presence of ascorbic acid was caused by 1500 times its weight amounts of vanadium(IV), 700 times amounts of cobalt, 500 times amounts of copper, 70 times amounts of nickel, or 25 times amounts of chromium(III). Titanium, molybdenum, tantalum, and tungsten interfere. Methods were developed for determining 0.1 to 3% of niobium in alloys based on iron and tin. The relative error of a determination is ±2.4%. (auth)

26986 THERMOGRAVIMETRIC ANALYSIS. Green, H. F.; Steed, K. C. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Progr. Nucl. Energy, Ser. IX; 10: 35-58(1970).

The contribution of thermogravimetric analysis to the chemistry of potential reactor fuel materials such as the oxides, carbides, and nitrides of U and Pu, is discussed in regard to studies on their thermal properties, including stability, reactivity, and reaction kinetics. The subject is discussed under the following headings: thermobalance specification and design (types of thermobalances – deflection type balances, null position balances; general design principles; furnace design and temperature control; glove box design); remote weighing (manually and automatically controlled systems; remote balance point detection); experimental systems (practical remotely controlled thermobalance; glove box operation); and application of thermogravimetric analysis to radioactive materials. 28 references. (UK)

26987 REMOTE PIPETTING. Maddox, W. L. (Oak Ridge National Lab., Tenn.). Progr. Nucl. Energy, Ser. IX; 10: 59-82(1970).

One of the principal determinants of the design of remote pipetting equipment is the kind of facility in which the apparatus must work, and the requirement to accomplish the necessary manipulations in a reasonable time. Various designs for special requirements are described, together with some commercial apparatus employed in hot laboratories. The subject is discussed under the following headings: custom apparatus (pipette controllers – diaphragm controllers, electrical syringe controllers; piston pipettes – design considerations, oil-filled pipettes – the buffer liquid method, ORNL applications, LRL – Livermore automatic electrical micropipette, servo pipettes; Eurochemic pipettes); commercial apparatus (dispensers and diluters; electrical controllers; piston pipettes or burettes). 20 references. (UK)

26988 APPLICATION OF TITRIMETRY TO REMOTE ANALYSIS. Thomason, P. F. (Oak Ridge National Lab., Tenn.). Progr. Nucl. Energy, Ser. IX; 10: 83-105(1970).

A description is given of titrators and titrations in which a liquid titrant is added to a system either manually or automatically, with emphasis on newly developed titrators designed for the analysis of highly radioactive samples. The various types of indicators used to show the equivalence point and the advantages and disadvantages of each are also described. The titrimetric determination of U and Pu is discussed in detail. Headings are as follows: history of titrimetry; effect of radiation on titrimetry; automatic titrators (remote controlled for applications in a hot cell); manual titrators; indication systems (potentiometric; amperometric; conductometric; photometric; miscellaneous); and titrations (determination of U and Pu). Care and maintenance problems are stressed. 69 references. (UK)

26989 FISSION GAS COLLECTION AND TRACE GAS ANALYSIS. Jennison, E. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Progr. Nucl. Energy, Ser. IX; 10: 225-54(1970).

The subject is discussed under the following headings: fission gas collection (general; separation and purification of Kr and Xe; gas collection during irradiation and analysis; post-irradiation analysis); trace gas analysis (general; vacuum fusion; inert gas fusion; halogenation and pyrolysis; other methods of analysis). 137 references. (UK)

26990 SPECTROGRAPHIC ANALYSES IN CONTAINMENT FACILITIES. Gaddy, R. H. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Progr. Nucl. Energy, Ser. IX; 10: 255-87 (1970).

It is stated that relatively few completely remotely operated facilities have been built for spectrographic analysis, but there are a number of "containment" (semi-remote or glove box) facilities in use, and a typical example is described. A description is also given of spectrographic analytical procedures that were applied to radioactive samples, with emphasis on those used for impurity analyses in the actinide elements. Headings are as follows: hood operations; glove boxes (design, materials, and operations); spectrographic systems; methods of analysis (carrier distillation method; copper spark method; impurity concentration by extraction and by ion exchange; total or direct burn); shielded excitation stands. 34 references. (UK)

26991 INSTRUMENTAL METHODS: SPECTROPHOTOMETRY, ATOMIC ABSORPTION, AND FLAME EMISSION SPECTROMETRY. Dykes, F. W.; Ryder, W. A.; Wheeler, G. V. (National Reactor Testing Station, Idaho Falls, Idaho). Progr. Nucl. Energy, Ser. IX; 10: 289-305(1970).

These techniques are discussed under the following headings: spectrophotometry (general; preliminary evaluation; special problems-radiation effects, corrosion and decontamination, maintenance and disposal, operational techniques; applications); atomic absorption and flame emission spectrometry (general; remote operation; non-remote operation). 39 references. (UK)

26992 APPLICATION OF ELECTROCHEMICAL TECHNIQUES TO REMOTE ANALYSIS. Shults, W. D. (Oak Ridge National Lab., Tenn.). Progr. Nucl. Energy, Ser. IX; 10: 307-57(1970).

Electrochemical methods of analysis for remote operation are considered. Topics covered include: effects of radiation on electroanalytical measurements; techniques involving direct measurement of some electrical property of a solution (potentiometry – pH measurements, ion-selective electrodes, redox potential, measurements; conductometry-measurements at audio frequencies, oscillometry and measurements at radio frequencies); techniques involving insignificant changes in overall composition resulting from the measurement (direct-current polarography; "Tast" polarography; voltammetry and chronopotentiometry; alternating current polarography and other non-direct current techniques – ac and square wave polarography, cathode ray and differential cathode ray polarography; amperometric titrametry); and techniques involving significant change in overall composition (electro-deposition; controlled current coulometry; controlled potential coulometry). The possible applications of thin-layer electrochemistry are mentioned. (297 references) (UK)

Isotopic Procedures

26993 DETERMINATION OF FLUORIDE BY SUBSTOICHIOMETRIC ISOTOPE DILUTION. Carmichael, I. A.; Whitley, J. E. (Scottish Research Reactor Centre, Glasgow). Analyst; 95: 393-5(Apr 1970).

A rapid simple determination was developed for fluoride ions in the 25 to 150 μg range by stoichiometric solvent extraction into chloroform with tetraphenylstibonium sulfate reagent. The tracer fluoride solution was labeled with fluorine-18 prepared by neutron irradiation of lithium carbonate. Halides interfere, but not sulfate or phosphate. (auth) (UK)

Radiometric Procedures

Refer also to abstracts 27338, 27348, 27353, 27378, 27388, and 27396.

26994 (CEA-R-3889) SEPARATION AND DETERMINATION OF KRYPTON AND XENON BY GAS PHASE RADIOCHROMATOGRAPHY. Charrier, Guy (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Mar 1970. 48p. (In French). Dep. CFSTI (U. S. Sales Only).

The optimum conditions for separating and detecting ^{85}Kr and ^{133}Xe by gas-phase chromatography were determined. An ionization chamber with a small-volume circulation was used as a detector. The analytical parameters (reproducibility, sensitivity) were studied in an activity range from 5×10^{-3} to 100 μCi. Fission gases obtained from irradiated uranium degassing were analyzed. Very low specific burnups can be determined. (France)

26995 (UJV-2315-A,Ch) EQUIPMENT FOR MECHANIZATION OF ANALYTICAL OPERATIONS. Talas, M.; Sraier, V.; Cerny, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Mar 1970. 18p. Dep. CFSTI (U. S. Sales Only).

Equipment was developed for remote analytical operations and determinations (potentiometric titrations and photometry) allowing analytical control of the reprocessing of spent nuclear fuel by countercurrent extraction and for the preparation of samples for radiochemical measurements. The equipment, its location, shielding, use, and control are described. (auth)

26996 EXAMINATION OF SURFACES BY SCANNING WITH CHARGED-PARTICLE BEAMS. Pierce, T. B. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Soc. Anal. Chem.; 7: 59-60(Mar 1970).

Since charged particles lose energy relatively rapidly on passage through matter, the interaction of low-energy particles is restricted to the surface layers of a thick target, and only a limited volume of sample will be irradiated if the diameter of the primary incident particle beam is small. Analytical methods based on charged-particle irradiation can thus be readily adapted to scanning operation, provided that prompt radiation emitted during the irradiation can be measured. Charged-particle microprobe techniques, however, are at an early stage of development, but their ability to provide analytical methods for the determination of light elements, such as C and H, has prompted recent studies. The analytical methods are based on the measurement of prompt γ radiation, particle groups produced as a result of nuclear reaction, or particles scattered elastically from the sample during irradiation. Each of these processes is briefly discussed, and it is stated that any of the three methods can be used in scanning techniques provided that the diameter of the incident particle beam is restricted and that the region of the sample from which the radiation yield is emitted is known. With regard to the provision by particle accelerators, of small-diameter ion beams suitable for microprobe work, it is stated that by combination of four specially designed quadrupole lenses in a Russian quadruplet arrangement, beam diameters <4 μm can be achieved. Restriction of beam diameter limits the total available beam current, but 6nA of 3 MeV protons have been obtained with a 3-MeV electrostatic generator. Scanning of the beam across the sample can be carried out by moving the position of the sample with respect to the beam either mechanically or by electrostatic beam deflection. So far, positive ion microprobe techniques have found their main application in the determination of light elements, such as B, C, N, O, F, Mg, and Al, distributed in surfaces, or for examination of thin films of light elements present on sample surfaces, for example films containing C and O on metal substrates. Elastic scattering has been used to study thin films of some heavy elements, for ex-

ample contaminant films of heavy elements on the surface of alumina insulators, and gold films on Si slices. (UK)

26997 MEASUREMENT OF THE RADON CONCENTRATION BY FILTER PACK METHOD. Ikebe, Yukimasa; Shimizu, Kuniyasu; Kawano, Minoru (Nagoya Univ., Japan). Oyo Butsuri; 39: 114-18(Feb 1970). (In Japanese).

The filter pack method used for measuring the radon concentration in air is described. The radon concentration may be estimated by this method assuming radioactive equilibrium among radon and its daughter products. The absolute collection efficiency of a millipore filter whose pore size was 0.3 μ was examined, and it was clarified that the filter collects almost perfectly radioactive aerosols in the air. The radon concentration in the air was measured simultaneously by the charcoal trap method and the filter pack method. The filter pack method was found to be fairly useful for measuring radon concentration in the air. (auth) (NSA of Japan)

26998 PROCESS FOR NON-DESTRUCTIVELY MEASURING THE PLUTONIUM CONTENT OF OBJECTS. (to Alkem, Alpha-Chemie und-Metallurgie GmbH). British Patent 1,187,886. 15 Apr 1970. Priority date 21 Nov 1967, Germany.

A nondestructive measurement of the Pu content of objects, particularly fuel elements, can be achieved by the simultaneous or successive measurement of the α-decay heat and the neutron emission rate. The quantity of material and the material identity are determined both from the absolute values of these two measurements and from their ratio to one another. (B.L.M.)

26999 AN EVALUATION OF FILM DETECTION METHODS FOR WEAK β-EMITTERS, PARTICULARLY TRITIUM. Randerath, Kurt (Harvard Univ., Boston). Anal. Biochem.; 34: 188-205(Mar 1970).

A systematic study of the factors influencing the speed of tritium detection on chromatograms is reported. A method that makes possible the visualization on thin-layer chromatograms of 2 to 3 nanocurie $^{3}H/cm^{2}$ and of 0.05 to 0.06 nanocurie $^{14}C/cm^{2}$ after an exposure for 24 hr is described. Results indicate that, in the presence of scintillator, the visualization of tritium is primarily due to the interaction of photons with the emulsion (fluorography), whereas the detection of low activities of ^{14}C (2 to 3 nanocurie/cm^{2}) is predominantly an autoradiographic process entailing the direct interaction of the ^{14}C β-particles with the emulsion. (J.G.B.)

27000 DETERMINATION OF ^{14}C IN BIOLOGICAL MATERIAL BY FLASK COMBUSTION AND SUSPENSION SCINTILLATION COUNTING OF ^{14}C LABELLED CALCIUM CARBONATE. Lloyd-Jones, C. P. (Univ. of Bristol, Eng.). Analyst; 95: 366-9(Apr 1970).

Aqueous sodium hydroxide solution is used as the absorbent in an oxygen-flask technique to avoid the risk of an explosion when an organic liquid absorbent is introduced into an oxygen atmosphere. Calcium carbonate is precipitated in the solution in the presence of hydroxypropyl methylcellulose, which produces uniform precipitates giving reproducible count rates. (auth) (UK)

27001 DETERMINATION OF URANIUM CONTENT IN STANDARD ROCKS BY FISSION-TRACK REGISTRATION IN MUSCOVITE. Nishimura, Susumu (Univ. of Osaka). Radioisotopes (Tokyo); 19: 194-6(Apr 1970).

Uranium contents in the six U. S. Geological Survey standard rocks together with JG-1 and JB-1, issued by the Geological Survey of Japan, were analyzed by the technique of fission-track activation using a thin muscovite film placed over the sample to detect tracks from it. With a thin section of a rock sample, it is often observed that uranium distribution is not uniform as supposed from the pattern of fission-tracks registered in polycarbonate by thermal neutron induced fission of uranium in the sample. Hence, to obtain the mean uranium content in rocks, the pulverized rock sample was used. (auth)

27002 ANALYSIS BASED ON IONIZATION EFFECTS OF RADIOACTIVE RADIATIONS. Toelgyessy, Juraj (Slovak Technical Univ., Bratislava). Jad. Energ.; 16: 109-21(Apr 1970). (In Czech).

Analytical methods based on the utilization of ionization effects of radiation are described in the article. Instruments used in gas chromatography (ionization detectors), and instruments analyzing gaseous and vapor mixtures without chromatographic separation, using different ionization properties (ionization analyzers) were characterized. The use of alpha and beta ionization for pressure, density, and flow measurements in gases is considered. (auth)

27003 CONTINUOUS DETERMINATION OF THE CONCENTRATION OF CADMIUM IN A FLOWING SOLUTION BY NEUTRON ABSORPTION. Kartashev, E. R.; Shtan, A. S. Tr., Vses. Nauch.-Issled. Inst. Radiats. Tekh.; No. 2, 145-55(1968). (In Russian).

A standard Pu–Be source (≈4.6×10^{6} n/sec), placed in a vertical channel along the axis of a paraffin wax cylinder (diameter 60 cm, height 60 cm), is used. The neutron detector is placed in a channel along the axis of a 1.5-liter measuring chamber containing the test solution. The method can be used to determine up to 20 g of Cd/l with a mean error of ±5%, both in isolated samples and in a continuous flow of solution through the measuring chamber. The sensitivity is 0.25 g of Cd/l. Accompanying elements do not affect the analytical results significantly. (Referativnyi Zh.)

27004 A PROCESS FOR PREPARING COMPOUNDS LABELLED WITH ^{14}C. Adloff, Jean-Pierre; Kuhry, Jean George (to Commissariat a l'Energie Atomique). British Patent 1,189,639. 29 Apr 1970. Priority date 23 Dec 1966, France.

A process for preparing ^{14}C-labeled compounds comprises neutron irradiation of a metallic nitride to convert N atoms to ^{14}C atoms, hydrolysis of the irradiated product, and subjecting the ^{14}C-methane resulting from the hydrolysis to an electrical discharge. In the presence of O, the electrical discharge produces ^{14}C-labeled CO_2. In the absence of O, labeled hydrocarbons having the same specific activity as the labeled methane are produced. (B.L.M.)

27005 DETERMINATION OF THE URANIUM CONTENT IN BIOLOGICAL MATERIAL BY MEANS OF NUCLEAR FISSION AS DEMONSTRATED IN MILK. Wiechen, A. (Bundesanstalt fuer Milchforschung, Kiel). Milchwissenschaft; 25: 95-8(1970). (In German).

A method is described for determination of ^{235}U in milk in amounts of the order of one part per 10^{12} and, by assuming a natural isotopic abundance ratio, the content of natural uranium can be calculated. The milk was ashed and pressed into tablets. The tablets were fixed on absorber films of polycarbonate and then irradiated in a thermal neutron flux of 10^{13} n cm^{-2} sec^{-1}. Fission tracks were observed in the absorber films. (tr-auth)

27006 LOSS OF ^{35}S-LABELED ELEMENTARY SULFUR DURING COUNTING. Shikata, Eiji; Tanase, Masakazu; Kase, Toshio. J. Nucl. Sci. Technol. (Tokyo); 7: 210-12(Apr 1970).

The decrease in counting rate of sulfur-35 during assay with a GM-counter due to evaporation of solid sulfur was studied. Temperature, amount of sulfur, and kinds of atmosphere are considered as underlying factors. Results of attempts to minimize the effect of evaporation are considered. (J.G.B.)

27007 COMPARISON OF FISSION TRACK METHOD AND ALPHA PARTICLE METHOD FOR DETECTION OF ACTINIDE NUCLIDES. Hashimoto, Tetsuo (Kyoto Univ.). Jap. Anal.; 19: 508-13(Apr 1970). (In Japanese).

A new method based on the count of alpha particle tracks for the detection of natural alpha nuclides on electromigrating paper by the use of celluloid film was reported recently. The fission track method using muscovite was investigated for the detection of uranium and thorium. Sample solutions in various concentrations were electromigrated on a filter paper and subjected to the detection of fission track after irradiation with reactor neutrons by combining with the chemical etching of muscovite surface. This method was satisfactory for the study of uranium distribution on migrated paper. In the case of thorium, the sensitivity of this method was poor as expected from the cross section value. Results of the fission track and alpha track methods were compared. The exposure time for alpha track recording was 1 day and 4.21×10^{16} n/cm^{2} was the total flux of thermal neutron for fission track experiment. The ratios between alpha tracks and fission tracks, as functions of specific activity for each actinide nuclide, are given. The fission track method is recommended for the following nuclides: ^{235}U, ^{233}U, ^{245}Cm, ^{239}Pu, ^{229}Th, ^{249}Cf, ^{237}Np, and spontaneous fissile nuclides (^{254}Cf, ^{252}Cf, ^{253}Es, ^{254m}Es). The alpha track method is recommended for the following: ^{226}Ra, ^{228}Th, ^{242}Cm, ^{223}Ra, ^{227}Ac, ^{230}Th, ^{231}Pa, ^{240}Pu, ^{243}Am, ^{241}Am, ^{238}Pu, ^{227}Th, ^{233}U, and other alpha nuclides. Fission or alpha methods may be used for ^{243}Cm, ^{234}U, and ^{242}Pu. (auth)

27008 LUNAR AND PLANETARY SURFACE ANALYSIS USING NEUTRON INELASTIC SCATTERING. Waggoner, J. A. (Univ. of California, Livermore). Int. Ser. Monogr. Anal. Chem.; 35: 165-93(1970).

The subject is discussed under the following headings: introduction and description of neutron interactions; survey of other nuclear and atomic compositional analysis methods (natural radioactivity; neutron capture gamma rays; neutron and alpha particle activation; neutron fast activation; Rutherford scattering; neutron die-away; fluorescent radiation; x-ray diffraction); experimental results of neutron inelastic scattering; effective sample size (data reduction and background evaluation; geometrical con-

straints); instrumentation for flyable neutron-gamma analytical systems (neutron sources; gamma ray detectors; pulse height analyzers and telemetry requirements; construction materials and shielding). It was concluded that neutron inelastic scattering would give optimum results for unmanned missions. (15 references.) (UK)

Activation Procedures

Refer also to abstract 28069.

27009 (AE-389) HIGH-SPEED, AUTOMATIC RADIOCHEMICAL SEPARATIONS FOR ACTIVATION ANALYSIS IN THE BIOLOGICAL AND MEDICAL RESEARCH LABORATORY. Samsahl, K. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Apr 1970. 18p. Dep. CFSTI (U. S. Sales Only).

An ion-exchange and extraction chromatographic separation method suitable for the simultaneous determination of up to 40 elements in reactor-irradiated biological material was developed. The method, being automated, requires a separation time of exactly 5 minutes for up to 4 samples. The method may be shortened essentially without modification in numerous ways for the purpose of determining a reduced number of selected constituents or even single elements. The separations are sufficiently fast also for multielement determinations in biological material irradiated for a short period with 14-MeV neutrons from a neutron generator. (auth) (Sweden)

27010 (IAN-Q-8) DETERMINATION OF TRACES OF SELENIUM AND TELLURIUM IN SULFUR BY NEUTRON ACTIVATION. Arroyo A., Alfredo; Toro G., Jaime (Instituto de Asuntos Nucleares, Bogota (Colombia). Seccion de Radioquimica). 1968. 14p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

The method described makes it possible to assure a sensitivity of determination of 0.07 μg of selenium and of tellurium in the presence of sulfur with a considerable saving of time in relation to other analytical methods of adequate precision. Repeated experiments were carried out on samples of equal selenium and tellurium content, and the results showed that the method is very consistent, i.e., the error is less than 1%. The isotopes of selenium and tellurium selected make it possible to obtain a sharp spectrum, which facilitates carrying out the analysis and avoids expensive radiochemical separations. (tr-auth)

27011 (WSUNRC-97) GAMMA RAY ENERGY TABLES FOR NEUTRON ACTIVATION ANALYSIS. Filby, R. H.; Davis, A. I.; Wainscott, G. G.; Haller, W. A. (comps. and eds.) (Washington State Univ., Pullman. Nuclear Radiation Center); Cassatt, W. A. (comp. and ed.) (Joint Center for Graduate Study, Richland, Wash.). Oct 1969. 237p.

The tables of γ rays emitted by (n,γ)-produced nuclides were assembled as a file of nuclear data on nuclides of interest in thermal neutron activation analysis. Nuclides produced by (n,p), (n,α), and (n,2n) reactions are also listed where reactor neutron cross section data are available. Three standard listings are ordered by energy, nuclide, and half-life. (M.C.G.)

27012 MEASUREMENT OF THE CONCENTRATION OF SOME ELEMENTS BY THE INDIRECT ACTIVATION METHOD. PART II. ISOTOPE ANALYSIS OF LITHIUM. Selecki, A.; Starosta, A. (Warsaw Technical Univ.). Isotopenpraxis; 6: 67-9(Feb 1970).

A method is described for lithium isotope analysis using a small, on the order of 10^6 n/s, neutron source. The method consists in activation of an indium plate located between two paraffin shields with the lithium compound to be analyzed. (auth)

27013 POTTERY ANALYSIS BY NEUTRON ACTIVATION. Perlman, I.; Asaro, F. (Univ. of California, Berkeley). Archaeometry; 11: 21-52(1969).

The method employed for cleaning and preparing pottery samples for neutron activation is described. The analysis equipment consisted of a germanium detector and a 1600-channel analyser. Results were computer processed. The program of irradiations, cooling periods, and counting periods is discussed from which a total of 37 isotopes were identified and measured. Standardization of the system, possible errors, and grouping of the analytical data obtained are discussed. An appendix lists relevant information of all isotopes and experimental techniques used for each element found in standard pottery. (UK)

27014 NONDESTRUCTIVE ACTIVATION ANALYSIS OF ANCIENT COINS USING CHARGED PARTICLES AND FAST NEUTRONS. Meyers, J. (Institut voor Kernphysisch Onderzoek, Amsterdam). Archaeometry; 11: 67-83(1969).

Copper and silver in gold coins were determined by 30-MeV proton activation; copper, gold, and lead in silver coins were determined by 26-MeV deuteron activation; and iron, nickel, zinc, arsenic, antimony, tin, and lead in copper coins were determined by fast-neutron activation. The results obtained from analysing many coins are reviewed. The relative merits of these techniques compared with those of x-ray fluorescence and thermal neutron activation analysis are discussed. (UK)

27015 ACTIVATION ANALYSIS OF CHLORINE, BROMINE, AND IODINE IN BIOLOGICAL MATERIALS. Ishii, Daido; Nakashima, Masahiko (Nagoya Univ., Japan). Radioisotopes (Tokyo); 19: 129-35(Mar 1970). (In Japanese).

A method has been developed for the determination of trace amounts of chlorine, bromine, and iodine in biological materials. After thermal neutron irradiation of the sample for 20 minutes at a flux of 2×10^{13} n·cm^{-2}·sec^{-1}, followed by rapid chemical separation, chlorine, bromine and iodine were determined by gamma spectrometry. The sample was transferred to the distillation flask together with 0.2 mmoles each of KCl, KBr, and KI carrier. It was decomposed by a concentrated HNO_3 and concentrated H_2SO_4 mixture. Iodine and bromine were distilled at this step. Potassium permanganate solution was then added to the flask to form chlorine. During the process the distillate was absorbed in the Na_2SO_3 solution. Then for the determination of iodine, accurate 0.1 mmoles of $AgNO_3$ was added to the solution and 0.1 mmoles of negatively charged colloidal pure AgI was formed. It was precipitated by $Al(NO_3)_3$ 9 H_2O and filtrated. The gamma activity of ^{128}I was counted immediately. For determination of others an excess of $AgNO_3$ was added to the filtrate, the precipitate containing AgI, AgBr, and AgCl was filtrated, the activity of ^{38}Cl was counted immediately, and, after the ^{38}Cl decay, the activity of ^{82}Br was counted. The gamma activity of the sample was counted with a 3in.φ × 3in. NaI(Tl) crystal connected to a TMC 256 channel pulse height analyzer. The chemical yields were about 100 percent with halogens, and the separation time was 30 ~ 50 minutes for iodine. The isolated precipitates of AgI were extremely pure. (auth)

27016 NEUTRON ACTIVATION ANALYSIS. Lange, H. Hegelund; Rasmussen, E. Gerhard. Tandlaegebladet; 73: 739-57(Sep 1969). (In Danish).

The physical principles of neutron activation analysis are outlined. The scintillation counter and the semiconductor detector are briefly described. The methods of radiochemical separation are mentioned, in particular the method developed by Samsahl and his coworkers. Some practical aspects of neutron activation analysis are commented upon, and the sensitivity of neutron activation analysis is discussed. A review of neutron activation analysis in dental research is given regarding trace element concentrations in enamel, dentin, pulp, calculus, saliva, and the mandibular disc. Reference is given to an investigation into the penetration of inorganic ions from dental restorations into enamel and dentin. (auth)

27017 DETERMINATION OF SODIUM, POTASSIUM, COPPER, AND IRON IN CANDIDA SPECIES. Pijck, J. (Univ. of Ghent). Sabouraudia; 7: 90-7(Jun 1969).

After pointing out the importance of trace elements for normal fungal activity, some of these elements were qualitatively and quantitatively determined in different species of Candida. Na, K, Cu, and Fe were quantitatively determined by radioactivation analysis or by spectrophotometry. The results were reproducible and were not noticeably influenced by the trace-element concentration of the culture medium employed. (auth)

27018 NEUTRON ACTIVATION LOGGING FOR SILICON TO ALUMINUM RATIOS. Wichmann, P. A.; Webb, R. W. J. Petrol. Technol.; 22: 201-6(Feb 1970).

A method of neutron activation logging is described for determination of the Si : Al ratio of both cased and uncased wells. The results of the logging technique are compared with both laboratory tests and production data; and although the results are not spectacularly quantitative, they have yielded answers of sufficient qualitative significance to encourage further testing of similar methods of logging. The technique is helpful in differentiating clean sand from its shaly counterparts. (B.L.M.)

27019 DETERMINATION OF FLUORINE BY NEUTRON-ACTIVATION ANALYSIS. Jeffery, P. G.; Bakes, J. M. (Warren Spring Lab., Eng.). Proc. Soc. Anal. Chem.; 7: 71(Apr 1970).

Types of reaction that occur when stable atoms are subjected to irradiation by charged particles and by neutrons were reviewed. Sources of neutrons were explained and compared. Their utility in determining fluorine was examined, reaction by reaction, in the light of competing reactions, likely interferences, and convenience in use. (auth) (UK)

27020 NEUTRON ACTIVATION ANALYSIS FOR MERCURY. Ishida, K. (Univ. of Chiba, Japan); Kawamura, S.; Izawa, M. Anal. Chim. Acta; 50: 351-3(May 1970).

Studies were made to develop a neutron activation method for determination of Hg which would be generally applicable to a variety of samples. Rice, dried cuttlefish, and rock were chosen as representatives. The materials were neutron irradiated and induced Hg activities were separated by a single-step anion exchange based on the selective adsorption of Hg on DEAE in thiocyanate media. Mercury activities thus obtained were sufficiently pure to allow direct gross γ-activity measurement. Because of the simplicity of the procedure, 8 samples can easily be treated by one worker at the same time with high chemical yields of about 75%. (P.C.H.)

27021 A COMPARISON OF THE USE OF CUPFERRON AND OXINE IN THE SUBSTOICHIOMETRIC DETERMINATION OF MOLYBDENUM BY NEUTRON ACTIVATION. Baishya, N. K.; Heslop, R. B. (Univ. of Manchester, Eng.). Anal. Chim. Acta; 50: 209-17(May 1970).

Extraction into chloroform with substoichiometric amounts of 8-hydroxyquinoline and cupferron has been used for the determination of molybdenum in germanium dioxide. The effects of interfering metal ions on both methods of extraction have been studied A substoichiometric isotope dilution method with cupferron is feasible for milligram quantities of molybdenum but not for microgram quantities. (auth)

27022 NUCLEONICS. Lyon, W. S.; Ricci, E.; Ross, H. H. (Oak Ridge National Lab., Tenn.). Anal. Chem.; 42: No. 5, 123R-9R(Apr 1970).

Developments in tracer techniques, radioanalytical measurements, neutron activation, and other nuclear methods of analysis are reviewed. Topics covered include: absolute measurement of radioactivity, liquid scintillation counting, radioisotopes in chemical analysis, activation and nuclear reaction analysis, charged-particle methods, photon activation, and forensic activation. (217 references) (M.C.G.)

27023 RADIOMETRIC ANALYSIS BY FLOWING SAMPLE THROUGH A CLOSED SYSTEM. Starnes, Peter Edward (to Hilger and Watts Ltd.). U. S. Patent 3,508,048. 21 Apr 1970. Priority date 7 Apr 1966, Great Britian.

A method and apparatus are described for continuous neutron activation analysis of materials that are in either fluid or suspended form. The material is circulated at a substantially constant flow rate through a closed loop system; the material is activated during circulation by means of a neutron source; and the secondary radiation from the material is detected and measured. The circulation process is continued until equilibrium between activation and decay is substantially established and at least one level of secondary radiation has achieved a substantially constant value. The true or equilibrium constant value is determined from one or more measurements, and the analytical information is derived from the magnitude of the equilibrium constant value(s) by comparison with corresponding value(s) observed with standards under similar conditions. (B.L.M.)

27024 SELECTIVE ACTIVATION WITH NEUTRONS AND A MATHEMATICAL ANALYSIS OF DECAY CURVES IN GOLD DETERMINATION. Prouza, Zdenek; Rakovic, Miloslav (Charles Univ., Prague). Jad. Energ.; 16: 56-9(1970). (In Czech).

The method of activation with resonance neutrons was applied. It is based on thermal neutron elimination from the spectra of reactor neutrons using a cadmium filter. By this method such selectivity is reached that only integral measurements of the induced sample activity and the following decomposition of the measured decay curves are needed. (auth)

27025 EXTRATERRESTRIAL IN SITU 14 MeV NEUTRON ACTIVATION ANALYSIS. Hislop, J. S.; Wainerdi, R. E. (Texas A and M Univ., College Station). Int. Ser. Monogr. Anal. Chem.; 35: 195-207(1970).

The proposed application of fast neutron activation for the in situ analysis of the major constituents of rock surfaces, such as those of the Moon, is discussed. Headings are as follows: features of 14-MeV neutron activation; detection of activity; activation sources; conventional 14-MeV neutron activation analysis procedure; in situ 14-MeV neutron activation analysis; apparatus; theory of rock analysis; treatment of data; analytical results using the remote analysis system; sample size; small systems for space missions. It was concluded that the simplicity and proven potential of the method provide an excellent basis for its choice as a method of remote in situ analysis of rock materials, even under the regions of space applications. (19 references.) (UK)

27026 CYCLIC ACTIVATION ANALYSIS. Givens, W. W.; Mills, W. R.; Caldwell, R. L. (Mobil Research and Development Corp., Dallas). Nucl. Instrum. Methods; 80: 95-103(1970).

Cyclic activation analysis is a technique that utilizes very efficiently a low-output, pulsed source of neutrons and short-lived radioactivities for analytical purposes. With this technique radioactivities having half-lives of a few minutes to as short as a few milliseconds can readily be used as a basis for elemental analysis. A mathematical analysis of cyclic activation, some experimental studies verifying the mathematical predictions, application of the technique to a specific analysis problem, and some suggested areas where cyclic activation could possibly be used to good advantage are presented. (auth)

27027 SURVEY ANALYSIS OF IMPURITIES IN GALLIUM ARSENIDE BY INSTRUMENTAL NEUTRON ACTIVATION. Wolfstirn, K. B. (Bell Telephone Labs, Inc., Murray Hill, N. J.). J. Phys. Chem. Solids; 31: 601-12(Apr 1970).

A nondestructive investigation was made of six doped gallium arsenide crystals (Cr, O, Si, Ge) grown by the Bridgman, Czochralski and eutectic epitaxy techniques. The detection in the parts per billion to parts per million range and identification of radioisotopes of impurity elements having relatively short ($t_{\frac{1}{2}} \leq 0.5$ day) and moderately long ($t_{\frac{1}{2}} \geq 2$ to 250 days) half-lives was considered. The specific resistivity range from 0.003 to 10^6 Ω cm was studied. No direct correlation was established between resistivity and spectrum intensity except for one heavily Si-doped crystal. All gallium arsenide crystals contained silicon at levels of 4.3×10^{16} to 4.7×10^{17} atoms/cm^3. Other impurities detected were indium, gold, germanium, and zinc at concentrations $< 3 \times 10^{16}$ atoms/cm^3; none of these were consistent contaminants. Phosphorus and indium were identified in a Ge-epitaxy layer on a Si-doped GaAs substrate. Semi-insulating Cr-doped gallium arsenide crystals were analyzed for chromium and found to contain 9.8×10^{17} to 1.59×10^{18} Cr/cm^3. The chromium activation analysis results do not appear to bear any relationship with the concentrations derived from the electrical measurements and suggest the existence of an inhomogeneous second phase. Improvements in the instrumental technique, which can lead to the determination of additional elements for trace characterization of bulk and solution grown gallium arsenide, are discussed. (auth) (UK)

27028 NEUTRON ACTIVATION ANALYSIS OF IODINE IN TELLURIUM COMPOUNDS USING Ge(Li) DETECTOR. Tamai, Tadaharu; Hashimoto, Tetsuo; Matsushita, Rokuji; Iwata, Shiro (Kyoto Univ.). Jap. Anal.; 19: 502-7(Apr 1970). (In Japanese).

The determination of iodine content in various tellurium compounds was investigated by nondestructive reactor neutron activation analysis with a Ge(Li) detector, with which two gamma photopeaks, 441 keV from ^{128}I and 453 keV from ^{131}Te, were easily resolvable. A new method is proposed using the activity ratio of the photopeaks and compared with the ordinary calibration curve method at the 441-keV photopeak. From the application of these methods, it was found that iodine content of 1 to 100 ppM could be determined in tellurium compounds and that the detection limit of these methods was about 1 ppM. These two methods were conveniently applied to the analysis of some commercial tellurium compounds. (auth)

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Refer also to abstracts 27004, 27107, 27118, 27147, 27148, 27161, 27189, 27325, and 27762.

27029 (ANL-7615, pp 218-26) TABLES OF ABSORPTION CROSS SECTIONS, PHOTOIONIZATION YIELDS, AND PHOTOIONIZATION CROSS SECTIONS FOR SEVERAL GASES. Person, J. C.; Nicole, P. P. (Argonne National Lab., Ill.).

Tables of absorption cross sections, photoionization yields, and photoionization cross sections are presented for acetylene, propyne, propene, methanol, ethanol, and methyl bromide, and also for the perdeuterated analogues of these gases. For each gas, the data are reported for energies ranging from a value below the ionization potential up to 11.78 eV. (auth)

27030 (ANL-7615, pp 226-8) A METHOD FOR ESTIMATING THE RELATIVE IMPORTANCE OF THE PLATZMAN COMPETITIVE IONIZATION PROCESS FROM ISOTOPE EFFECTS IN MOLECULAR PHOTOIONIZATION. Person, J. C. (Argonne National Lab., Ill.).

A graphical method is presented for estimating the minimum contribution to the total ionization of the Platzman competitive ionization process from data on the ionization yield, η, for deuterated (η_D) and protonated (η_H) molecules. The method assumes that one may use the simple kinetic model proposed by Platzman in which the ionization occurs either by direct ionization or by the preionization of superexcited states in competition with atomic

rearrangement processes leading to neutral products. It is also assumed that deuteration does not change the part of the ionization yield that results from direct ionization. The results are given in a figure which shows the curves (for the different values of η_H) giving the maximum fraction of the ionization due to direct ionization as functions of a variable determined by the ratio of the observed η_D/η_H ratio to the maximum possible η_D/η_H ratio. Another figure plots the maximum η_D/η_H ratio for each value of η_H. (auth)

27031 (BAW-3714-16) GEL-ADDITION PROCESS CHEMICAL STUDIES. Quarterly Progress Report No. 14, November 1969–January 1970. Carlson, R. V. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Apr 1970. Contract AT(30-1)-3714. 26p. Dep. CFSTI.

The development of a sol-gel process and related processes for preparing $(U,Pu)O_2$ fast reactor fuels was continued. About 6 kg of $^{235}UO_2$ sol and 550 g of PuO_2 sol were prepared by precipitation-peptization techniques. The unit-operation-scale spheroidizing system was operated without the organic regeneration system. About 250 g of coarse and 150 g of fine $^{235}UO_2$–20% PuO_2 microspheres were prepared. The $^{235}UO_2$–20% PuO_2 pellets and shards required for the initial EBR-II irradiation test were nearly completed. Because of a design change in the EBR-II pins, additional UO_2 blanket and insulator pellets were prepared. Four capsules in a series designed to show the differences in restructuring kinetics of pellets and vibratory compacted spheres and shards were irradiated in the BAWTR. The exposure time varied from 3 to 81 days at 6 to 20 kW/ft. (auth)

27032 (CEA-R-3958) X-RAY-DIFFRACTION METHOD FOR THE DETERMINATION OF [HEXAGONAL] $\alpha-UO_3$ IN $\beta-UO_3$. Nicolas-Jarleton, Jacques (Commissariat a l'Energie Atomique, Ballancourt (France). Centre du Bouchet). Feb 1970. 32p. (In French). Dep. CFSTI (U. S. Sales Only).

The UO_3 structure can affect both the reduction reaction of the ammonium uranate and the reactivity of the UO_2 obtained. UO_3 is made up of different crystal phases, and the presence of hexagonal $\alpha-UO_3$ in the $\beta-UO_3 \cdot 0.5\ H_2O$ obtained industrially is exposed. It is necessary to determine the proportions of the various crystallographic phases present in UO_3, in order to favor the formation of those phases that lead to a better reaction yield and to a higher turnover of the production plant. The detection method makes it possible to identify the $\alpha-UO_3$ (H) by considering the (101) reflection, and to obtain a semiquantitative analysis with a detection threshold of 1.5% for $\alpha-UO_3$ by using the (001) reflection. Finally the quantitative analysis of $\beta-UO_3$ is made with precision from 0.8 to 2.7% by measuring the intensity of the (111) reflection of the $\alpha-UO_3$ (H). (France)

27033 (GAMD-9670(Rev.)) HYDROLYSIS OF URANIUM AND THORIUM CARBIDES. Burnette, R. D. (Gulf General Atomic, Inc., San Diego, Calif.). 1 Oct 1969. Contract AT(04-3)-167. 36p. Dep. CFSTI.

Experimental work performed from 1961 through 1969 on the hydrolysis of uranium and thorium dicarbides with particular emphasis on the effects of this process on the HTGR system is reviewed. The work included (1) basic reaction rate studies, (2) measurements of changes in gross physical parameters such as volume and density, (3) the effects of these changes on restraining graphite structures such as fuel element sleeves, and (4) fission-product release from irradiated fuel materials. The rate studies indicated that the reaction of water vapor with uncoated ThC_2 or UC_2 is rapid at all temperatures from ambient to 750°C. There is some indication of a minimum reaction rate around 400°C. The upper limit for the hydrolysis reaction is 500 to 600°C, above which pure oxidation occurs (i.e., conversion to ThO_2 or UO_2). Volume changes of up to 85% were observed for uncoated $(Th,U)C_2$ particles following hydrolysis at room temperature, with less expansion at higher temperatures. The release of noble gases from fuel materials undergoing hydrolysis was observed to be increased; however, escape of other fission products, such as iodine, was relatively insignificant. (auth)

27034 (NP-18216) SURVEY AND STUDIES ON THE SAFETY IN CONNECTION WITH SODIUM-WATER REACTIONS. A Report for the Fisical Year 1969. (Japan Society of Mechanical Engineers, Tokyo). 20 Mar 1970. 209p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

27035 (RT/ING-69)8) STUDY ON THE INTERACTION BETWEEN SODIUM, CERAMIC, AND FISSION PRODUCTS. Segre, G. J. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 14 Mar 1969. 68p. (In Italian). Dep. CFSTI (U. S. Sales Only).

An experimental program on sodium, ceramic material, and fission products reactions, connected both with the needs of the safety and the development of a ceramic fuel, is outlined. The work was focussed on the sodium–ceramic material compatibility and on the release, distribution, chemical state, and analysis of fission products. Experiments are described and analyzed in relation to the most significant parameters. (auth)

27036 (Y-1727) PREPARATION OF AMMONIUM DIURANATE AND DETERMINING ITS VISCOSITY-DENSITY RELATIONSHIP. Jeter, I. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 25 May 1970. Contract W-7405-eng-26. 11p. Dep. CFSTI.

Viscosity measurements were made on precipitated uranium diuranate slurries over density ranges from approximately 1.2 to 1.8 g/ml at a temperature of 25°C. Each density range showed decreasing viscosity with elapsed time, indicating that ammonium diuranate precipitates have thixotropic characteristics. (auth)

27037 DIFFUSION IN BINARY MIXTURES OF H_2, HD, AND D_2 AT 24°C. Mueller, K. P.; Klemm, A. (Max-Planck-Institut fuer Chemie, Mainz). Z. Naturforsch.; 25a: 243-6(Feb 1970). (In German).

Diffusion in a cylinder followed by catarometric analysis permitted the measurement of the inter-diffusion coefficient D in the systems H_2-HD, H_2-D_2 and $HD-D_2$ at 24°C and 760 torr with an estimated error of ±1%. A dependence of D on concentration did not show up. A least square fit combining the new measurements with less accurate earlier ones on systems containing tritium, yields the three coefficients of the expansion $(\sqrt{\mu}D)_{III} = 0.006\ m_{III} - 0.023(m^2_{13} - m^2_{14}) + 0.010(m^2_{AC} + m^2_{BD} - m^2_{ac} - m^2_{bd})$. μ is the reduced mass of the two molecules of a mixture, and in general $x_{ik} = (x_i - x_k)/(x_i + x_k)$. Roman numbers as indexes indicate mixtures, arabic ones molecules, and letters atoms. As for the masses $m_I = m_1 + m_2$, $m_{II} = m_3 + m_4$, $m_1 = m_A + m_C$, $m_3 = m_B + m_D$, $m_2 = m_a + m_c$, $m_4 = m_b + m_d$. The signs of the first two coefficients in the expansion agree with the second Chapan–Enskog approximation, and that of the third coefficient with the model of loaded spheres. (auth)

27038 STUDIES ON THE COMPOSITION AND STABILITY OF URANYL, VANADYL, AND TITANOUS COMPLEXES WITH SOME AMINO ACIDS. Farooq, Omar; Malik, A. U.; Ahmad, N.; Rahman, S. M. F. (Aligarh Muslim Univ., India). J. Electroanal. Chem.; 24: 464-7(1970).

The composition of the vanadyl, uranyl, and titanous complexes with various amino acids was determined conductometrically. The conductometric titrations were all reversible and in all cases a ratio of 1:1 (metal:amino acid) was established. The stability constants of the complexes are computed from the results of pH-metric titrations. (B.L.M.)

27039 PRODUCTION OF NITRIDES OF ACTINIDE METALS. (to W. R. Grace and Co.). British Patent 1,188,011. 15 Apr 1970. Priority date 1 Jun 1966, United States.

A process for preparing one or more of the nitrides, oxynitrides, carbonitrides, and carboxynitrides of an actinide metal, notably Pu, Th, or U, comprises heating in an atmosphere of N_2 the oxide of the metal in colloidal form in the presence of colloidal C or a carbide of the metal formed by heating in an inert atmosphere the oxide of the metal in colloidal form in the presence of colloidal C. All conversions are carried out at temperatures in excess of 1000°C and at a C:actinide ratio of ~2.4:1. (B.L.M.)

27040 ORGANIC SOLID STATE CHEMISTRY. A Symposium Held at Upton, N. Y., March 25–28, 1968. Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969). 520p. $34.50. (CONF-680333).

The conference proceedings are divided into the following sections: I. Structural Problems; II. Real Crystals; III. Generation and Study of Intermediates in Solid State Reactions; IV. Energy Levels, Excited States, Energy Transfer, and Electronic Processes; V. Solid State Reactions Other Than Polymerization; and VI. Solid State Polymerization. There is a total of 27 papers in the proceedings. Separate abstracts have been prepared for 13. (B.L.M.)

For abstracts of individual papers see: 27041–27044 and 27114–27122.

27041 GENERATION AND STUDY OF REACTION INTERMEDIATES IN ORGANIC SOLIDS. Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. pp 135-52 of Organic Solid State Chemistry. /Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From International Symposium on Organic Solid State Chemistry, Upton, N. Y. See CONF-680333.

Studies of free radicals, trapped electrons, cations, anions, and charge transfer complexes made possible by producing these species in glassy or polycrystalline organic matrices at temperatures such that both the rate of diffusion and the rate of reaction with the matrix are so low that the species may be observed for periods in the range of minutes to years are discussed. Meth-

ods of generating the species include photolytic rupture of bonds, photoionization, and ionization and excitation resulting from γ irradiation. These primary steps are, in some cases, followed by generation of secondary intermediates by dissociative electron capture processes and by abstraction of H atoms by hot radicals. The growth and decay of free radicals is most readily studied by ESR; of electrons by ESR and by near ir absorption, and of ions and charge transfer complexes by visible-uv absorption. Significant information on trapped electrons was obtained from the electric conductivity and luminescence of γ-irradiated matrices as a function of temperature during warm-up. Charged species may be identified, and the migration of charge studied, by the effects of charge scavenging additives. Examples of "radiation catalysis" of radical and electron decay are described. The implications of "pure" first order decay of radicals in some systems, and "composite" first order decay of radicals and electrons in other systems, are discussed. Examples of the saturation of electron traps at moderate doses and, at higher doses, the preempting of these traps by non-paramagnetic species are given. (auth)

27042 COMMENTS ON ELECTRONIC RELAXATION PROCESSES IN MOLECULAR CRYSTALS. Jortner, Joshua; Bixon, Mordechai (Tel-Aviv Univ., Israel). pp 213-37 of Organic Solid State Chemistry. /Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From International Symposium on Organic Solid State Chemistry, Upton, N. Y. See CONF-680333.

A theory of radiationless transitions in isolated molecules is presented, considering the decay of a compound molecular state into a quasi continuum of zero order vibronic levels. The theory is then applied to electronic relaxation processes in molecular crystals with emphasis on the implications of level shifts in solids, and the nature of the decay of metastable exciton states located above the direct threshold to the conduction band. (auth)

27043 REACTIONS IN SOLID BARIUM METHACRYLATE DIHYDRATE INDUCED BY HYDROGEN- AND DEUTERIUM-ATOM BOMBARDMENT. Heller, H. C.; Schlick, S.; Yao, H. C.; Cole, T. (Ford Motor Co., Dearborn, Mich.). pp 401-15 of Organic Solid State Chemistry. /Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From International Symposium on Organic Solid State Chemistry, Upton, N. Y. See CONF-680333.

Solid barium methacrylate dihydrate was exposed at room temperature to reaction with H and D atoms formed by an electrodeless discharge of H_2 and D_2, respectively. A detailed ESR study revealed that the reacting atoms cause the formation of three types of radicals in the solid: (1) An initial radical $CH_3-\dot{C}(CH_3)-COO^-(CH_2D-\dot{C}(CH_3)-COO^-)$ is formed by H atom (D-atom) addition to the double bond in the methacrylate ion, $CH_2=C(CH_3)-COO^-$. (2) A polymer (propagating) radical $RCH_2-\dot{C}(CH_3)-COO^-$ is formed by the topochemical reaction of the initial radical. (3) Computer simulation of the experimental spectra indicates the presence of a third unidentified radical species exhibiting a very broad (40 to 60 Gauss) single line. After annealing at 50°C for several hours, the H (or D) bombarded solid exhibits only the ESR signals due to the propagating radical. Similarities and contrasts between the present work and that of O'Donnell, McGarvey, and Morawetz [J. Am. Chem. Soc. 86, 2322 (1964)] on γ-irradiated barium methacrylate are discussed. (auth)

27044 POLYMERIZATION OF p-VINYLBENZAMIDE IN THE SOLID PHASE. Parrish, C. F. (Indiana State Univ., Terre Haute). pp 453-64 of Organic Solid State Chemistry. /Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From International Symposium on Organic Solid State Chemistry, Upton, N. Y. See CONF-680333.

A high degree of conversion can be obtained for the solid phase polymerization of p-vinylbenzamide when initiated thermally or by a post-irradiation technique. The Arrhenius activation energy for the radioinduced polymerization is 20.3 kcal/mole while the value for the thermally initiated polymerization is 25.8 kcal/mole. EPR data of the polycrystalline sample show a broad line spectrum which changes shape as the sample is heated from -196 (the irradiation temperature) to 105°C (the polymerization temperature). X-ray crystallographic and single-crystal EPR data along with the spectra of p-(β-dideuterovinyl)benzamide are presented. The system has an initial radical concentration of 5.9×10^{17} radicals/g and this concentration decreases only by a factor of 2 after heating for 38 hours at 105°C. (auth)

27045 THERMAL DECOMPOSITION OF NITRIDES OF SOME TRANSITION METALS IN AIR. Lyutaya, M. D.; Kulik, O. P.; Kachkovskaya, E. T. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 3, 72-5(Mar 1970). (In Russian).

The thermal decomposition in the air of titanium nitrides with ultimate composition and in the homogeneity region and nitrides of zirconium, hafnium, vanadium, and chromium was investigated by thermographic, chemical, and x-ray methods. The decomposition of titanium nitride started at 600°C. The decomposition of titanium, zirconium, hafnium, vanadium, and chromium nitrides at corresponding temperatures up to the highest oxides occurred through the formation of intermediate compounds of variable composition. (auth)

27046 PARAHYDROGEN CONVERSION ON 5A MOLECULAR SIEVE AND 5A MOLECULAR SIEVE CONTAINING NEODYMIUM IONS. Brown, D. E.; Eley, D. D.; Rudham, R. (Univ. of Nottingham, Eng.). J. Catal.; 16: 292-302(Mar 1970).

Parahydrogen conversion on 5A molecular sieve and 5A molecular sieve containing neodymium ions was investigated over the temperature range 77 to 605°K. Rates of orthodeuterium conversion at low temperatures and hydrogen–deuterium equilibration at high temperatures were measured in order to interpret the mechanism of reaction. At low temperatures conversion proceeds by a physical mechanism in which the activity is determined by paramagnetic impurities and neodymium ions. At high temperatures conversion proceeds by a chemical mechanism, and both catalysts exhibit a pronounced activation effect on exposure to hydrogen. The low temperature activity is unaffected by the hydrogen treatment. (auth)

27047 ION-PAIR REACTIVITY IN ISOTOPIC EXCHANGE REACTIONS. II. LITHIUM BROMIDE IN ACETONE AS SOLVENT. Beronius, Per; Isacsson, Ulf; Nilsson, Ann-Margaret (Univ. of Umea, Sweden). Acta Chem. Scand.; 24: 189-94(1970).

To establish whether ion-pairs of lithium bromide in acetone are kinetically active species, the exchange of ^{82}Br between this salt and butyl bromide was studied. Kinetic data were applied to the Acree equation for different values of the distance of closest approach of Li^+ and Br^- in the ion pair. The results indicate that the ion pairs are unreactive species. On the assumption that they consist of lithium and bromide ions in contact, the kinetic data yield an ion pair dissociation constant of 2.33×10^{-4} at 25° in close agreement with the value 2.14×10^{-4} according to conductivity data obtained in the present investigation. (Sweden)

27048 CRITERION FOR HYDROCARBON REACTIVITY IN CATALYTIC ISOTOPIC EXCHANGE WITH DEUTERIUM. Shopov, D.; Andreev, A.; Petrov, L.; Goudkov, B. (Inst. of Organic Chemistry, Moscow. Inst. of Organic Chemistry, Sofia). Compt. Rend. Acad. Bulg. Sci.; 22: 1273-5(1969).

Studies were made on the hydrogen–deuterium exchange in paraffin and cyclohexane hydrocarbons on a Ni catalyst. The magnitude delocalizability, obtained on the basis of quantum-chemical calculations, as a criterion for the reactivity of hydrocarbons with respect to the reaction of catalytic isotope exchange with deuterium, is proposed. It was concluded that the mean delocalizability $D^{(R)}_{mean}$ is a convenient magnitude for an objective characterization of the reactivity of saturated hydrocarbons in a reaction of catalytic hydrogen–deuterium exchange. The correlation obtained may be considered as a confirmation of the participation of σ-bound surface compounds during the exchange of paraffin and cyclohexane hydrocarbons under the examined conditions. The results confirmed the deduction about the appreciable effect of the steric factor in the deutero-exchange of compounds with a pronounced configurational difference. (P.C.H.)

27049 ISOTOPE EFFECT ON PHYSICAL ADSORPTION. di Corcia, Antonio; Liberti, Arnaldo (Univ., Rome). Trans. Faraday Soc.; 66: 967-75(Apr 1970).

The gas-chromatographic technique is useful for study of isotope effects on adsorption at zero coverage. Experimental data for several isotopic pairs, adsorbed on various surfaces at various temperatures, are discussed in terms of the theory of isotope effects in condensed systems. The variation of the logarithm of the gas-chromatographic isotopic separation factor is approximately described by a relationship of the type $B/T - A/T^2 + C$. The reverse isotope effect can be quantitatively explained by differences in adsorption potentials, produced by differences in polarizability, without invoking any decrease in the molecular stretching frequencies on adsorption. The B term, responsible for the cross-over phenomenon, is related to differences in polarizability and good agreement is found for isotopic pairs which definitely exhibit non-specific interactions with the adsorbing media. Deviations of up to 50%, which were found for isotopic pairs containing double bonds, are discussed briefly in terms of a slight specific interaction with the adsorbing media and differences in equilibrium distances with respect to the adsorbing surface. (auth) (UK)

27050 ELECTRONIC STATES OF MOLECULES AND THEIR PHOTOCHEMICAL DECOMPOSITION IN THE CON-

DENSED PHASE. II. DECOMPOSITION OF HYDROCARBONS INTO RADICALS. Plotnikov, V. G. Opt. Spectrosc. (USSR) (Engl. Transl.); 27: 322-6(Oct 1969).

Translated from Opt. Spektrosk.; 27: 593-600(Oct 1969).

The processes involved in the quenching of the excited states of hydrocarbons as a result of the decomposition of the molecule into radicals have been examined. It has been found that the predissociation of a polyatomic molecule corresponds to a process of electronic energy redistribution, which takes place in a time interval which is smaller by 4 to 6 orders of magnitude in the triplet state than in the singlet state. The photochemical stability is related to the position and nature of the triplet states. The rate constants for the decomposition of the molecules have been estimated, and the isotope effect is discussed. (auth)

27051 THE SHIFT IN THE VIBRATIONAL FREQUENCIES OF HYDROGEN AND DEUTERIUM IN THE CASE OF THE GAS-SOLUTION PHASE TRANSITION. Arkhangelskaya, O. I.; Bakhshev, N. G. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 382-3(Oct 1969).

Translated from Opt. Spektrosk.; 27: 702-4(Oct 1969).

Studies were made on the shift ($\Delta\nu = \nu_{soln} - \nu_{gas}$) of the vibrational frequencies of hydrogen and deuterium within the framework of the theory of the effects of universal (van der Waals) forces on the vibrational spectra of molecules. It was concluded that the frequency shift in the case of the gas-solution phase transition of H and D is of a nonspecific nature, and is determined mainly by the effects of dispersion forces. (P.C.H.)

27052 HEATS OF FORMATION OF GASEOUS ThF_3 AND ThF_2 FROM MASS SPECTROMETRIC STUDIES. Zmbov, K. F. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). J. Inorg. Nucl. Chem.; 32: 1378-81(Apr 1970).

Mass spectrometry was used to investigate high-temperature equilibria involving ThF_4, ThF_3, ThF_2, Ca, and CaF and the data obtained were utilized to determine heats of formation of gaseous ThF_2 and ThF_3. The gaseous species were produced by heating a powdered mixture of CaF_2 and metallic Th in a Knudsen cell attached to the mass spectrometer. Appearance potentials were measured and established the existence of Ca, CaF, ThF_4, ThF_3 and possibly ThF_2 molecules above Th–CaF_2 at temperatures above 1250°C. The ionization efficiency curve of the ThF_3^+ ion from the CaF_2–Th system showed features indicating a contribution of at least two independent processes in the formation of this ion, and the same applied to the ionization efficiency curve of the ThF_2^+ ion. The intensities of the observed ions were measured as a function of temperature at electron energies 4 eV above threshold and were used to calculate the equilibrium constants and heats of reaction. The heats of formation of $ThF_{3(g)}$ and $ThF_{2(g)}$ were calculated as −259.1 and −137.3 kcal/mole, respectively. (UK)

27053 NATURE OF THE PRECIPITATED HYDRATED OXIDES OF THE ELEMENTS OF GROUP IV A. I. THERMAL ANALYSIS AND INFRARED SPECTROSCOPY. Vivien, Daniel; Livage, Jacques; Mazieres, Charles (Ecole Nationale Superieure de Chimie, Paris, Paris Univ., Orsay, France). J. Chim. Phys.; 67: 199-204(Jan 1970). (In French).

Thermal analysis and infrared spectroscopy showed that precipitated amorphous oxides of Ti, Zr, Hf, and Th are hydrated hydroxides $MO_{2-x}(OH)_{2x} \cdot yH_2O$. They contain water molecules more or less bonded to the solid and also OH groups bonded (in increasing number from Ti to Th) to the metal atom. This is equivalent to the situation in aqueous solution where the cation is surrounded by an increasing number of −OH groups as one goes through the series Ti, Zr, Hf, Th. A correspondence exists between the infrared M-O absorption bands of the hydrated hydroxides and those in the crystallized oxides obtained by heating. This supports previous structural results that the amorphous state is intermediate between the hydrolyzed ion and the crystallized oxides. (France)

27054 GYROTROPY OF CUBIC CRYSTALS OF URANYL COMPOUNDS. Kizel, V. A.; Krasilov, Yu. I.; Burkov, V. I.; Madii, V. A.; Alikhanova, Z. M. Opt. Spectrosc. (USSR)(Engl. Transl.); 27: 344-7(Oct 1969).

Translated from Opt. Spektrosk.; 27: 635-42(Oct 1969).

The results of a study on the dispersion of optical activity of isomorphic cubic crystals of uranyl compounds, such as sodium uranyl acetate and ammonium, potassium, rubidium, and cesium uranyl propionates, are presented. The possibility of using the Kramers–Kroenig relationships for describing the gyrotropy and circular dichroism in these single crystals is verified. A qualitative explanation of the main features of the phenomenon of gyrotropy in uranyl crystals, which occurs only in the crystal state, is given. (auth)

27055 PREPARATION AND SEVERAL PROPERTIES OF $K_4Th(HPO_4)_2(C_2O_4)_2.6H_2O$. Molodkin, A. K.; Balakaeva, T. A.; Kuchumova, A. N. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 15: 1152-3(Apr 1970). (In Russian).

A mixed oxalatophosphate complex of thorium, $K_4Th(HPO_4)_2(C_2O_4)_2 \cdot 6H_2O$, was synthesized. The synthesis of the compound was based on a partial substitution of oxalate groups by phosphate in a tetraoxalate $K_3Th(C_2O_4)_4 \cdot nH_2O$ complex. Thermogram and thermogravitation diagrams are included. Data obtained suggested the following formula for the mixed thorium oxalatophosphate complex: $K_4[Th(HPO_4)_2(C_2O_4)_2(H_2O)_2] \cdot 4H_2O$. (R.V.J.)

27056 SPECTRAL STUDIES ON SOME ORGANIC COMPLEXES OF URANYL ION. PART I. ABSORPTION SPECTRA OF PYRIDINE COMPLEXES. Sanwal, D. N.; Pant, D. D. (Government Coll., Nainital, India). Proc. Indian Acad Sci., Sect. A; 70: 221-33(Nov 1969).

The absorption spectra of new crystalline uranyl complexes with pyridine, at 80° K are described. Pyridine uranyl chloride crystallized in two forms, both forms gave sharp line like bands at low temperatures. In Form I the bands were analyzed in terms of five electronic transitions F, M, D, U, and SU. Results on analogous compounds with deuteropyridine are also reported. The chloride complex seemed to have pyridine in the first coordination sphere while the acetate complex was of the double salt type. (auth)

27057 DENSITIES OF AQUEOUS KCl AND UO_2SO_4 FROM 25 TO 374°C. Bell, J. T.; Helton, D. M.; Rogers, T. G. (Oak Ridge National Lab., Tenn.). J. Chem. Eng. Data; 15: 44-6(1970).

The densities of 0.1, 0.5, and 1.0M solutions of KCl and of 1.27M UO_2SO_4 were observed at temperatures between 25 and 374°C. These data are reported as density vs. temperature, and the isotherms of density vs. concentration are shown for the KCl solutions. The change in the densities of the KCl solutions at 25°C is a linear function of the KCl concentration, but this linear relationship disappears at higher temperatures, and the greatest change in the solution density per unit of KCl concentration occurs between 0 and 0.1M. Between 0.1 and 1.0M KCl, the density change for the KCl solutions at the higher temperatures is a linear function of the KCl concentration. The change in the density of the UO_2SO_4 solution over any temperature range is greater than the density changes for the KCl solutions over the same range, and is most notable at temperatures above 250°C. (auth)

27058 PHOTOCHEMICAL FORMATION OF FREE RADICALS FROM ACETONITRILE AS STUDIED BY ELECTRON SPIN RESONANCE. Svejda, P.; Volman, D. H. (Univ. of California, Davis). J. Phys. Chem.; 74: 1872-5(30 Apr 1970).

Electron spin resonance studies of $CH_3C^{14}N$, $CH_3C^{15}N$, and $CD_3C^{14}N$ irradiated at 185 nm in the frozen state at 77°K were made. Evidence for two primary processes was obtained: cleavage of the carbon–carbon bond; cleavage of a carbon–hydrogen bond. Frozen solutions of acetonitrile–aqueous hydrogen iodide irradiated at 254 nm were also studied. Evidence for addition of a hydrogen atom to acetonitrile to form ethylidenimino radical was found. INDO calculations of coupling constants for ethylidenimino and cyanomethyl radicals were in general agreement with the observed spectra. (auth)

27059 THE ROLE OF HINDERED ROTATION IN THE PHYSICAL ADSORPTION OF HYDROGEN WEIGHT AND SPIN ISOMERS. Gant, P. L. (Continental Oil Co., Ponca City, Okla.); Yang, K.; Goldstein, M. S.; Freeman, M. P.; Weiss, A. I. J. Phys. Chem.; 74: 1985-91(30 Apr 1970).

Gas adsorption chromatographic techniques were used to study the limiting absorptions of all six weight isomers of molecular hydrogen on Molecular Sieve 4A in the temperature range from 169 to 219°K. Further, the separation factors for $o\text{-}H_2/p\text{-}H_2$ are also determined in the range from 135 to 160°K. It was found that adsorption models based on the Kirkwood–Wigner partition function (developed for spherical molecules through terms in $\hbar^4$) are inadequate to explain the observed relative adsorptions and of course they predict no separation of the spin isomers. On the other hand, an adsorption model based on a hybrid partition function which takes full account of molecular rotation and libration (developed for adsorption on a plane surface elsewhere) fits the differenced data of the symmetric weight isomers to within experimental precision with reasonable values of the parameters, but for two different energies. The fit of this model to the raw data gives essentially the same parameters with substantially greater residual error, probably reflecting the departure of molecular sieve geometry from a plane surface. No attempt was made to include the asymmetric weight isomers in this analysis because of clear-cut inconsistency with behavior predicted by the hybrid-partition-function model. Furthermore, the

observed o-H_2/p-H_2 separation factors are accounted for to within the ambiguity of this hybrid-partition-function model, demonstrating that the effects of hindered rotation are of paramount importance in this temperature regime for the adsorption of molecular hydrogen. (auth)

27060 DETERMINATION OF THE TRANSPORT CONSTANTS OF THE COMPLEX ISOTOPIC EXCHANGE BETWEEN HYDROGEN AQUEOUS VAPOR AND WATER IN AN EXPERIMENTAL APPARATUS. Hodor, L.; Morar, N.; Peculea, M.; Sampaleanu, L. (Inst. of Atomic Physics, Cluj). Stud. Cercet. Fiz.; 21: 1105-13(1969). (In Rumanian).

The efficiency of deuterium transport between a flow of water vapor-saturated hydrogen and a water film was studied in a countercurrent column. Isotopic transfer between the liquid film and its vapor did not depend on the total pressure in the column, and increased with increasing vapor pressure in the reactant mixture. Isotopic transfer between H_2 and H_2O vapors reached a maximum value with increasing pressure ratio $\chi = p_{H_2O}/(p_{H_2O} + p_{H_2})$; as the total pressure increased, the maximum value shifted toward the greater values of χ. The isotopic balance error in the experiments was not greater than ±5%. Interpretation of experimental data was made on the basis of a theory describing the complex isotopic transfer by simultaneous distillation and isotopic exchange reaction between three fluids flowing countercurrent. (auth)

27061 CRYOMETRIC MEASUREMENT OF THE DISTRIBUTION COEFFICIENTS FOR THE TRIVALENT RARE EARTH IONS DISSOLVED IN THE ALKALINE EARTH FLUORIDES IN SOLID SOLUTION AND IN IGNEOUS MOLTEN SOLUTION NEAR THE LIMIT OF INFINITE DILUTION. Delbove, Francois; Lallemand-Chatain, Simone (Paris Univ.). Compt. Rend., Ser. C, 270: 964-6(16 Mar 1970). (In French).

The distribution coefficients of the rare earths, La, Ce, Pr, Nd, Sm, Gd, Y, and Yb were determined in liquid and solid phases by high temperature cryometry in CaF_2, SrF_2, and BaF_2. (J.G.B.)

27062 PREPARATION AND CHARACTERIZATION OF PHASES IN THE $Hf(SO_4)_2$–H_2O SYSTEM. Bear, I. J.; Mumme, W. G. (Commonwealth Scientific and Industrial Research Organization, Melbourne). J. Inorg. Nucl. Chem.; 32: 1159-64 (Apr 1970).

Eleven phases in the $Hf(SO_4)_2$–H_2O system were prepared either by dehydration of solid $Hf(SO_4)_2 \cdot 4H_2O$ or by rehydration of the anhydrous product. Crystallographic and x-ray powder diffraction data are presented, from which it was established that most of these compounds are isomorphous with corresponding phases in the $Zr(SO_4)_2$–H_2O system. A hafnium analogue of the β-$Zr(SO_4)_2 \cdot H_2O$ has not yet been prepared, however an additional anhydrous $Hf(SO_4)_2$ was observed. (auth) (UK)

27063 MIXED LIGAND CHELATES OF YTTRIUM(III) IN AQUEOUS SOLUTION. Oezer, U Yuecelik (Middle East Technical Univ., Ankara). J. Inorg. Nucl. Chem.; 32: 1279-85(Apr 1970).

Mixed ligand chelates of 1:1 yttrium(III)-ethylenediaminetetraacetic acid (EDTA) and -hydroxyethylethylenediaminetriacetic acid (HEDTA) chelates with various secondary ligands were investigated at 25.0°C in 0.1M KNO_3 by a potentiometric method. Stability constants were obtained for the EDTA and HEDTA chelates with the secondary ligands disodium 1,2-dihydroxybenzene-3,5-disulfonate (Tiron), sodium 2,3-dihydroxynaphthalene-6-sulfonate (DHN), pyrocatechol(PY), hydroxyethyliminodiacetic acid (HIMDA), and iminodiacetic acid (IMDA), but could not be obtained for salicylic acid (SA), 5-sulfosalicylic acid (5 SSA), and potassium hydrogen phthalate (KHP). Mixed ligand chelates of HEDTA are more stable than those of EDTA. (auth) (UK)

27064 INFLUENCE OF PRIMARY SODIUM PHOSPHATE ON THE DEPOSITION OF URANIUM ON NICKEL. Hoelgye, Z. (Uranindustrie, Pribram, Czech.). Collect. Czech. Chem. Commun.; 35: 679-83(Feb 1970). (In German).

The effects of sodium phosphate on the deposition of microgram and milligram amounts of uranium on nickel plates were investigated. The effects of time, acid concentration, and temperature were studied. (M.C.G.)

27065 INSERTION REACTIONS OF MONO- AND DIFLUOROCARBENE WITH HYDROGEN HALIDES. Small, Thomas; Rowland, F. S. (Univ. of California, Irvine). J. Phys. Chem.; 74: 1866-71 (30 Apr 1970). Contract AT-(11-1)-34.

Both monofluorocarbene ($CH^{18}F$) and difluorocarbene ($CF^{18}F$) react in direct insertion reactions with hydrogen halides to form $CH_2^{18}FX$ and $CHF^{18}FX$, respectively. The fluorocarbenes are produced by secondary decomposition reactions of excited ^{18}F-labeled molecules formed by hot ^{18}F atom reactions with various precursor molecules, including CF_4, CHF_3, CH_2F_2, and C_2F_4. Competitive studies show rapidly decreasing reactivity of HX toward $CF^{18}F$ in the order HI > HBr > HCl. The reaction of $CH^{18}F$ with HI forms $CH_2^{18}FI^*$ with sufficient excess energy to decompose these molecules to $CH_2^{18}F$ and I in gas-phase experiments. The scavenging of $CH^{18}F$ by two successive reactions with HI thus results in the formation of $CH_2^{18}F$. The exothermicity of the other reactions forming $CH_2^{18}FX$ and $CHF^{18}FX$ is insufficient for appreciable secondary decomposition. (auth)

27066 2491-A ABSORPTION SYSTEM OF NO_2 AND A DOUBLE-MINIMUM POTENTIAL. Coon, J. B.; Cesani, F. A.; Huberman, F. P. (Texas A and M Univ., College Station). J. Chem. Phys.; 52: 1647-54(15 Feb 1970).

The 2491-Å absorption system of $N^{16}O_2$ and the corresponding system of $N^{18}O_2$ were photographed at temperatures up to 600°C. For each molecular species measurements yielded the ground-state frequencies ν_1'', ν_2'', $2\nu_1''$, and $\nu_1'' + \nu_2''$ as well as the excited-state frequencies ν_1', ν_2', and $2\nu_2'$. A large isotope shift observed for the (0–0) band was found to be consistent with the assignment $2\nu_2' = 713\ cm^{-1}$ even though this frequency was quite small compared to the frequency $\nu_1' = 1156\ cm^{-1}$. Two facts that demand explanation are the isotope shift of the frequency $2\nu_2'$, and the relative intensity of the cold band involving $2\nu_2'$. These facts cannot be explained in terms of harmonic potential in the antisymmetrical coordinate Q_3', but can be explained in terms of a double-minimum potential in this coordinate. The barrier of this potential is about $722\ cm^{-1}$ and the inversion doubling is near $103\ cm^{-1}$. At vibrational equilibrium the calculated N–O bond lengths are 1.426 and 1.202 Å. (auth)

27067 CALCULATION OF THE VAPOR-PRESSURE RATIO OF THE ISOTOPES OF SOLID Ne AND Ar. Klein, M. L. (National Research Council of Canada, Ottawa); Blizard, W.; Goldman, V. V. J. Chem. Phys.; 52: 1633-5(15 Feb 1970).

The improved self-consistent phonon theory of Goldman, Horton, and Klein for the Helmholtz energy of anharmonic crystal was used to calculate the vapor-pressure ratios of the common isotopes of Ne and Ar. For both substances, a Mie–Lennard–Jones (m–6) nearest-neighbor potential (m = 12 and 13) with parameters chosen to fit the zero-temperature latent heat and molar volume is found to give reasonable agreement with experiment. (auth)

27068 HOT-ATOM REACTIONS IN THE PHOTOLYSIS OF DEUTERIUM CHLORIDE AT 1849 A. Wood, Gerry O.; White, John M. (Univ. of Texas, Austin). J. Chem. Phys.; 52: 2613-21(1 Mar 1970).

The importance of hot deuterium atoms in photolyses of DCl–Cl_2 mixtures at 1849 Å was demonstrated, and the kinetics of this system are described. Photodecomposition of DCl was followed by mass-spectrometric analysis of the D_2 formed after successive intervals of time. The observed decreases in the initial rate of D_2 formation on addition of Cl_2 and inert gases CO_2, Xe, and CF_4 may be readily interpreted in terms of a hot-atom mechanism but cannot be made compatible with a completely thermal mechanism. Rate coefficient ratios for the hot-atom reactions, (2) $D^* + DCl \rightarrow D_2 + Cl$, (3) $D^* + M \rightarrow D + M$, (6) $D^* + Cl_2 \rightarrow DCl + Cl$, were found to be $k_6/k_2 \approx 6.5$, $k_3^{DCl}/k_2 = 0.65$, $k_3^{CO_2}/k_2 = 1.15$, $k_3^{CF_4}/k_2 \approx 1.15$, and $k_3^{Xe}/k_2 < 0.1$. The ratio k_6/k_2 increased from 6.5 in the absence of inert gas to 9.2 when $[CO_2]/[DCl] = 1.87$. This ratio increased to ≈300 for a thermal atom distribution at 300°K. Comparisons of thermalizing efficiencies for several molecules suggest that inelastic collisions are important in thermalizing hot atoms produced photochemically at 2.1 eV. (auth)

27069 RATE CONTROLLING STEP OF UF_4–BrF_3 AND U_3O_8–BrF_3 REACTION. Sakurai, Tsutomu. J. Nucl. Sci. Technol. (Tokyo); 7: 176-81(Apr 1970).

The reactions of gaseous BrF with UF_4 and U_3O_8, under varying diffusivity of BrF_3 brought about by changing the carrier gas, were studied to determine the rate-controlling step. Helium gas used as the carrier brought about a reaction rate twice as high as that with N_2 and Ar. These relative reaction rates were not affected by changes in linear gas velocity, BrF_3 partial pressure, or reaction temperature; and their ratio is roughly equal to the theoretical ratio between the diffusivity of the three carrier gases. The temperature dependence of the reaction rates also supports the conclusion that the reaction is diffusion-controlled. (J.G.B.)

27070 REACTION OF URANIUM(VI) WITH CHROMAZUROL S. Chiacchierini, E. (Univ., Rome); Sepel, T.; Sommer, L. Collect. Czech. Chem. Commun.; 35: 794-818(Mar 1970).

The analytical reaction of UO_2^{2+} with Chrome Azurol S was studied spectrophotometrically, and equilibrium and stability constants were determined. Mononuclear and dinuclear complexes of UO_2^{2+} were formed, and by varying pH and concentration either

$[UO_2(RH^+)]^-$ or $[(UO_2)_2R]^0$ can be made to predominate. At pH > 5 all complexes were hydrolyzed. (J.G.B.)

27071 REACTION OF URANIUM MONOCARBIDE AND URANIUM CARBONITRIDES WITH WATER. Benadik, A.; Benadikova, H. (Inst. of Nuclear Research, Rez, Czech. Inst. of Chemical Tech., Prague). Collect. Czech. Chem. Commun.; 35: 915-22(Mar 1970).

The kinetics of the hydrolytic decomposition of uranium carbides and carbonitrides under isothermal conditions was studied over the temperature range 18 to 80°C. Rate constants and activation energies were determined, and a mechanism for the hydrolysis is proposed. The rate of the hydrolytic decomposition of monocarbide is controlled by the rate of a process on the outer oxide surface, probably the decomposition of adsorbed water molecules. (J.G.B.)

27072 ATMOSPHERIC CORROSION OF URANIUM MONOCARBIDE, MONONITRIDE, AND CARBONITRIDES. Benadik, A. (Inst. of Nuclear Research, Rez, Czech.). Collect. Czech. Chem. Commun.; 35: 988-93(Mar 1970).

Low-temperature corrosion of sintered samples of uranium monocarbide, carbonitrides, and mononitride in the presence of laboratory air (relative humidity 30 to 70%) and moist (relative humidity 75%) and dry air, nitrogen, and argon, was studied. It was found that the stability of carbonitrides in all media is higher than the stability of monocarbide. The extent of corrosion decreases with the increase of the nitrogen content in carbonitrides. Corrosion was least in dry nitrogen and argon. (J.G.B.)

27073 INFRARED AND RAMAN SPECTRA, CONFORMATION, AND VIBRATIONAL ASSIGNMENT OF ACETIC AND PERDEUTEROACETIC ANHYDRIDES. Mirone, Paolo (Univ. of Modena, Italy); Fortunato, Bruno; Canziani, Paola. J. Mol. Struct.; 5: 283-95(Apr 1970).

The infrared spectra of gaseous, liquid, and crystalline $(CH_3CO)_2O$ and $(CD_3CO)_2O$ were studied (200 to 4000 cm^{-1}) together with the Raman spectra of the liquids. The possibility of a coexistence of two isomeric forms was discussed, and it was concluded that most probably only one form is present. On the basis of the number of polarized Raman lines and of the intensity ratio between the absorption bands due to carbonyl stretchings, this form should have a non-planar skeleton and belong to the symmetry group C_2. A complete vibrational assignment, consistent with the Teller–Redlich product rule and with previous assignments for related molecules, is proposed for both $(CH_3CO)_2O$ and $(CD_3CO)_2O$. (auth)

27074 THE EXCHANGE REACTION BETWEEN $H_2{}^{18}O$ AND ACETIC, MONOCHLOROACETIC, DICHLOROACETIC, AND TRICHLOROACETIC ACIDS. McTigue, P. T.; Renowden, P. V.; Watkins, A. R. (Melbourne Univ., Parkville, Australia). Aust. J. Chem.; 23: 381-4(Feb 1970).

The ^{18}O exchange reaction between water and chlorinated carboxylic acids is interpreted in terms of the mechanism $A + H^+ \underset{K_{-1}}{\overset{k_1}{\rightleftharpoons}} AH^+$; $AH^+ + H_2O \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} AH(OH) + H^+$ (the latter being rate-determining nucleophilic attack on acetic acids, protonated by a strong acid). Salt effect studies gave imprecise results. There was little variation in exchange rate constant from acetic acid (4.3×10^{-4} l $mole^{-1}$ sec^{-1}) through to trichloroacetic acid (1.4×10^{-3} l $mole^{-1}$ sec^{-1}). The solvent deuterium isotope effect must also be about the same for acetic and chloroacetic acids. The isotope effect is seen as being largely secondary on the initial pre-equilibrium stage. (Australia)

27075 FURTHER STUDIES ON TEMPERATURE DEPENDENCES OF ISOTOPE EFFECTS. Spindel, W. (Yeshiva Univ., New York); Stern, Marvin J.; Monse, E. U. J. Chem. Phys.; 52: 2022-35(15 Feb 1970).

It is shown that, although the temperature behavior calculated in the harmonic approximation for a specific isotope-exchange reaction may be extremely sensitive to the force fields used in the computations, small force-field changes do not affect significantly the overall prevalence of temperature-dependence "anomalies." In a series of calculations for a large number of ^{13}C, ^{18}O, and D isotope-exchange equilibria involving organic and inorganic molecules, such "anomalies" were found in 50 of the 171 ^{13}C exchanges considered, in 84 of the 153 ^{18}O exchanges considered, and in 40 of the 120 D exchanges considered. When the results were combined with previous results for ^{15}N- and ^{18}O-exchange reactions involving simple inorganic molecules, "anomalies" appeared in about 40% of the almost 700 reactions investigated. It was concluded that isotope-effect temperature-dependence "anomalies" are not due to unusual or fortuitous combinations of force constants, but represent a more general phenomenon. Further, the phenomenon is not restricted to particular structural features in molecules or to isotopes of particular elements. (auth)

27076 PHOSPHORESCENCE AND ZEEMAN SPECTRA OF ANTHRACENE IN A MIXED CRYSTAL. Clarke, Richard H. (Univ. of Pennsylvania, Philadelphia). J. Chem. Phys.; 52: 2328-32(1 Mar 1970).

Phosphorescence was observed at 4.2°K for anthracene-h_{10} and anthracene-d_{10} dissolved in a phenazine host crystal. The sharp-line spectra permit a detailed analysis of the anthracene vibrational frequencies and the observation of the Zeeman splitting of the emitting triplet level. Analysis of the relative intensities among the Zeeman components of the electronic origin of emission in a 40.6-kG magnetic field shows that a long-axis spin state provides 95% of the radiative spin-state activity in the anthracene phosphorescence. (auth)

27077 POLARIZED INFRARED SPECTRA OF TCNQ AND TCNQ-d_4 SINGLE CRYSTALS. Lunelli, Bruno; Pecile, Cesare (Univ., Padua). J. Chem. Phys.; 52: 2375-84(1 Mar 1970).

The infrared-active vibrations of the TCNQ (tetracyanoquinodimethane) molecular structure were investigated by using the spectra of the powder and those of the (001) and (010) crystal planes in polarized radiation for both TCNQ and its fully deuterated analog. These measurements give most of the significant indications that can be drawn from infrared spectra for the localization and symmetry class identification of infrared active modes. As a result, a well-based assignment of infrared-active fundamentals, as well as some information on crystal field effects and on the optical behavior of this anisotropic crystal in the (010) plane, is given. (auth)

27078 α-AMINO ALCOHOLS AS PRODUCTS OF A REDUCTIVE SIDE REACTION OF DENATURED COLLAGEN WITH SODIUM BOROHYDRIDE. Paz, Mercedes A.; Henson, Edward; Rombauer, Robert; Abrash, Lorraine; Blumenfeld, Olga O.; Gallop, Paul M. (Yeshiva Univ., New York). Biochemistry; 9: 2123-7(12 May 1970).

Evidence is presented for the occurrence of a small level of a peptide bond reductive side reaction, during the treatment of denatured collagen with sodium borohydride. The resulting α-amino alcohols led to the earlier and erroneous conclusion that α-amino aldehydes were present in this protein. Experimental approaches with tritiated sodium borodeuteride, which were used to establish the origins of α-amino alcohols, are described. The use of tritiated sodium borodeuteride practically eliminates the chromatographic isotopic effect prevalent in the purification of derivatives of the amino alcohols when prepared with tritiated sodium borohydride. Accordingly, specific activity measurements can now clearly determine if one or two nonexchangeable tritium atoms are incorporated during a reduction, and this can be confirmed by mass measurements that establish whether one or two nonexchangeable deuterium atoms are also present. (auth)

27079 HYDROGEN–DEUTERIUM SELF-EXCHANGE IN HYDROGEN SULFIDE AND HYDROGEN SELENIDE AS STUDIED WITH A PULSED-MOLECULAR-BEAM QUADRUPOLE MASS FILTER. Pyper, J. W.; Newbury, R. S. (Univ. of California, Livermore). J. Chem. Phys.; 52: 1966-71(15 Feb 1970).

The equilibrium constants for hydrogen–deuterium self-exchange in hydrogen sulfide and hydrogen selenide were studied over a wide range of deuterium atom percent using a pulsed-molecular-beam quadrupole mass filter. K_{HDS} was found to be 3.88 ± 0.03 at 24.0 ± 0.4°C and K_{HDSe} was found to be 3.92 ± 0.04 at 22 ± 1°C. The experimental results agree with calculations from spectroscopic data to within 1%. It is shown that equilibrium constants for self-exchange reactions in systems where two hydrogenic species are exchanged tend toward the geometric mean value of K = 4 in the series $H_2O : H_2S : H_2Se$ as expected from theory. (auth)

27080 HEAT CAPACITY, ENTHALPY OF FUSION, AND THERMODYNAMIC PROPERTIES OF NpF_6 FROM 7 TO 350°K. Osborne, Darrell W.; Weinstock, Bernard; Burns, John H. (Argonne National Lab., Ill.). J. Chem. Phys.; 52: 1803-10(15 Feb 1970).

Measurements of the heat capacity of NpF_6 from 7 to 350°K by adiabatic calorimetry are reported. No anomalies were observed in the heat-capacity curve. The triple point was 327.91 ± 0.02°K, and the enthalpy of fusion was 4188.4 ± 4.0 cal $mole^{-1}$. Thermodynamic functions were tabulated at selected temperatures. At 298.15°K, C_p°, S°, $H^\circ - H_0^\circ$, and $(G^\circ - H_0^\circ)/T$ for solid NpF_6 are 40.02 ± 0.08, 54.76 ± 0.11, 7436 ± 15, and 29.82 ± 0.06 cal $°K^{-1} \cdot mole^{-1}$, respectively. At 340°K, S° for gaseous NpF_6 is 94.09 ± 0.38 cal $°K^{-1} \cdot mole^{-1}$ from the calorimetric and vapor-pressure data, if Rln2 is added to the entropy obtained by extrapolation of the observed heat-capacity curve from 7 to 0°K. This value is in excellent agreement with S° calculated from statistical mechanics and molecular data. (auth)

27081 ESR STUDY OF THE KINETIC ISOTOPE EFFECT IN THE REACTION OF H AND D ATOMS WITH CH_4. Kurylo, Michael J.; Hollinden, Gerald A.; Timmons, Richard B. (Catholic Univ. of America, Washington, D. C.). J. Chem. Phys.; 52: 1773-81(15 Feb 1970).

ESR atom detection was employed to determine the kinetic isotope effect involved in the reactions: $H + CH_4 \rightarrow H_2 + CH_3$ and $D + CH_4 \rightarrow HD + CH_3$. New data were obtained for the first reaction leading to a slightly revised value for k_1 of $(6.25 \pm 2.00) \times 10^{13} \exp[-(11,600 \pm 150)/RT]$ in units of $cm^3\ mole^{-1} \cdot sec^{-1}$. Assuming that the ratio of pre-exponential factors for reactions 1 and 2 is 1.38 a value for k_2 of $(4.5 \pm 2.0) \times 10^{13} \exp[-(11,100 \pm 150)/RT]\ cm^3\ mole^{-1} \cdot sec^{-1}$ was computed. The observed kinetic isotope effect was compared with those calculated from absolute rate theory using the semiempirical Sato potential energy surface, or that obtained from the empirical bond-energy–bond-order (BEBO) method. These two methods give equally good predictions of the value of k_1/k_2. Application of a one-dimensional tunnel correction results in poorer agreement between thecry and experiments. (auth)

27082 ELECTRONIC SPECTRA OF CESIUM FLUORIDE COMPLEXES OF PENTAVALENT NEPTUNIUM. Varga, L. P. (Oklahoma State Univ., Stillwater); Asprey, L. B.; Keenan, T. K.; Penneman, R. A. J. Chem. Phys.; 52: 1664-9(15 Feb 1970).

The absorption spectra of magenta-colored $CsNpF_6$ both as a mull of the crystalline solid and as a solution in $CsF \cdot 2HF$ were obtained under various conditions. The room-temperature spectra were unique to the electronic energy levels of the seven Russell–Saunders states for the $5f^2$ configuration, split by spin–orbit coupling into 13 free-ion levels; this confirmed the chemical evidence for the presence of pentavalent neptunium. At liquid-nitrogen temperatures the spectra of $CsNpF_6$ mulls were interpreted in terms of the free-ion f–f transitions of Np^{5+} split by an O_h crystal field. Term assignments to the following experimental energy levels obtained at room temperature were made on the basis of the observed Stark splitting in the low-temperature spectra, and agreement with calculated energy levels (in cm^{-1}): $^3F_2 = 4337$, $^3H_5 = 8425$, $^3F_3 = 8797$, $^3F_4 = 9701$, $^3H_6 = 13,738$, $^3P_0 = 16,129$, $^1D_2 = 16,736$, $^1G_4 = 18,265$, $^3P_1 = 19,531$, $^1I_6 = 20,619$, $^3P_2 = 26,667$. All levels above the $^3H_4$ ground state were observed except $^1S_0$. A least-squares fit of these experimental energy levels was made to the Racah Coulomb interaction parameters, $E^1 = 2807\ cm^{-1}$, $E^2 = 19.98\ cm^{-1}$, $E^3 = 284.1\ cm^{-1}$; the spin–orbit coupling parameter $\zeta = 2316\ cm^{-1}$; and the configuration-interaction parameters, $\alpha = 2.7\ cm^{-1}$ and $\beta = 52.9\ cm^{-1}$. The position of the $5f^2$ levels of Np^{5+} on the intermediate coupling diagram compared to the f^2 levels of the isoelectronic series Pr^{3+}, Nd^{4+}, Th^{2+}, U^{4+}, and Pu^{6+} (in PuF_6) was intermediate between U^{4+} and Pu^{6+} as expected. (auth)

27083 VIBRATION SPECTRA OF HYDROGEN BONDS BY NEUTRON ENERGY-LOSS SPECTROMETRY. Collins, M. F. (Atomic Energy Research Establishment, Harwell, Eng.); Haywood, B. C.; Stirling, G. C. J. Chem. Phys.; 52: 1828-31(15 Feb 1970).

A neutron spectrometer with a beryllium-filter detector has been used to obtain vibration spectra of a selection of hydrogen-bonded compounds in the range 400 to 1400 cm^{-1}. The neutron technique preferentially observes hydrogen motions, thus providing a less ambiguous assignment of modes than is possible in optical spectroscopy. Data are reported here for KHF_2, $CsHCl_2$, $NaHCO_3$, $KH(CF_3COO)_2$, and $KH(CCl_3COO)_2$. In the first three compounds the results provide confirmation of existing infrared and Raman assignments, and in the latter three cases the locations of the bending modes are indicated. (auth)

27084 LOW-FREQUENCY MODES IN MOLECULAR CRYSTALS. VI. METHYL TORSIONS AND BARRIERS TO INTERNAL ROTATION OF $C(CH_3)_4$, $C(CD_3)_4$, $Si(CH_3)_4$, $Ge(CH_3)_4$, AND $Sn(CH_3)_4$. Durig, J. R.; Craven, S. M.; Bragin, J. (Univ. of South Carolina, Columbia). J. Chem. Phys.; 52: 2046-52(15 Feb 1970).

The far-infrared spectra of $C(CH_3)_4$, $C(CD_3)_4$, $Si(CH_3)_4$, $Ge(CH_3)_4$, and $SN(CH_3)_4$ were recorded from 300 to 33 cm^{-1}. The f_1 torsional modes were observed at 281, 206, 177.5, 134, and 101.5 cm^{-1} and the a_2 torsional modes were assigned to bands at 221, 157, 163.5, 134, and 101.5 cm^{-1} for the $C(CH_3)_4$, $C(CD_3)_4$, $Si(CH_3)_4$, $Ge(CH_3)_4$, and $Sn(CH_3)_4$ molecules, respectively. The corresponding CH_3 torsional barriers were calculated to be 4.3, 4.6, 2.0, 1.3, and 0.8 kcal/mole. These barriers are shown to be consistent with those reported for the similar trimethyl molecules but are considerably higher than the barriers previously reported for these molecules from PMR studies. (auth)

27085 VIBRATIONAL SPECTRA OF SINGLE CRYSTALS. POLYMORPHIC SOLIDS OF CYCLOHEXANE-d_{12}. Brown, Chris W.; Obremski, Robert J.; Lippincott, Ellis R. (Univ. of Maryland, College Park). J. Chem. Phys.; 52: 2253-9(1 Mar 1970).

Single crystals of the two polymorphs of cyclohexane-d_{12} were grown using miniaturized high-pressure instrumentation. The infrared spectrum of a single crystal of solid I supports a cubic crystal structure with T_h^2 space group symmetry for this solid modification. Polarized infrared spectra of a single crystal of solid II and the infrared and laser-excited Raman spectra of a polycrystalline film were also measured. The splitting of the fundamental vibrational bands and the polarized infrared data are compatible with the previous results on cyclohexane-d_0 and confirm an orthorhombic D_{2h} crystal structure. (auth)

27086 WATER STRUCTURE IN SOLUTIONS OF THE SODIUM SALTS OF SOME ALIPHATIC ACIDS. Snell, Harriet; Greyson, Jerome (Rocketdyne, Canoga Park, Calif.). J. Phys. Chem.; 74: 2148-52(14 May 1970).

Entropies of transfer between heavy and normal water for the sodium salts of the group of aliphatic acids from the formate to the caproate were determined from combination of heats of transfer obtained from calorimetric measurements with free energies of transfer obtained from cell measurements. The standard heat of transfer for the process salt in heavy water to normal water was negative for sodium formate, near zero for sodium propionate and butyrate, and positive for sodium caproate. Solvent-structure influence, established from the sign and magnitude of the transfer entropies, indicated a transition from structure breaking to structure making in passing from sodium formate to sodium caproate. Increases in solute concentration lead to decreases in the absolute value of the entropy of transfer. The structure influence and the concentration dependence of the entropies of transfer of the salts are explained in terms of the Gurney cosphere model. (auth)

27087 EFFECTS OF DEUTERATION AND HEAVY ATOM ADDITIVES ON THE SCINTILLATION LIFETIME OF p-TERPHENYL IN BENZENE AT 22°. Lambrecht, R. M.; Kelly, T. M.; Merrigan, J. A. (Eastman Kodak Co., Rochester, N. Y.). J. Phys. Chem.; 74: 2222-4(14 May 1970).

Quenching of the scintillation lifetimes of p-terphenyl and p-terphenyl-d_{14} as a function of concentration of fluoro-, chloro-, bromo-, and iodobenzene and bromocyclohexane is presented. The results support the hypothesis that these additives affect the luminescence of p-terphenyl in benzene solvent by interfering with energy transfer from the solvent to the fluor. Data are presented in tables and graphs. (M.C.G.)

27088 INELASTIC NEUTRON SCATTERING SPECTRA AND RAMAN SPECTRA OF $CsHCl_2$ AND $CsDCl_2$. Stirling, G. C. (Oxford Univ.); Ludman, C. J.; Waddington, T. C. J. Chem. Phys.; 52: 2730-5(1 Mar 1970).

Neutron inelastic data and Raman spectral data on $CsHCl_2$ and $CsDCl_2$, in conjunction with earlier infrared data, confirmed the noncentrosymmetric nature of the bichloride ion in these salts. The inelastic neutron scattering data eliminate $D_{\infty h}$ as the point group of the ion and the Raman data show that the ion is bent, so that the ion belongs either to the point group C_{2v} or C_s. Reinterpretation of the infrared spectra suggests that the binding vibration in the ion is split by dynamical tunneling between the two possible bent configurations. (auth)

27089 INTRAMOLECULAR INTERACTIONS IN THE WATER MOLECULE: THE STRETCH–STRETCH INTERACTION FORCE CONSTANT OF WATER MOLECULES IN HYDROGEN-BONDED SYSTEMS. Fifer, R. A.; Schiffer, J. (Temple Univ., Philadelphia). J. Chem. Phys.; 52: 2664-70(1 Mar 1970).

A calculation is described for determining water molecule F_{rr} force constants from observed HOD, H_2O, and D_2O vibrational frequencies. The calculations for water in the vapor and in the hydrates $MnCl_2 \cdot 2H_2O$, $FeCl_2 \cdot 2H_2O$, $CoCl_2 \cdot 2H_2O$, and $CuCl_2 \cdot 2H_2O$ indicate a large increase in F_{rr} with hydrogen bonding. Various contributions to F_{rr} are considered, and its increase is attributed to an enhancement of the effective charge on water hydrogens with increased hydrogen bonding. (auth)

27090 INFRARED SPECTRUM OF CRYSTALLINE CH_2Cl_2 AND CD_2Cl_2. POLARIZATION MEASUREMENTS AND CRYSTAL STRUCTURE. Marzocchi, M. P.; Manzelli, P. (Univ., Florence). J. Chem. Phys.; 52: 2630-9(1 Mar 1970).

The infrared spectra of crystalline CH_2Cl_2 and CD_2Cl_2 were measured at temperatures ranging from 5 to 125 and at 85°K, respectively, between 5000 and 200 cm^{-1}. Splitting into two or more components was observed for several fundamentals. The mixed-crystal technique was used to prove the origin of the observed splittings, and the isotopic shifts for ^{37}Cl and ^{13}C as well as the factor-group splittings were identified. These data, together with polarization measurements on polycrystalline-oriented films,

relative intensity measurements, and other independent data, such as crystal density and Raman spectrum, were used to determine the crystal structure. The data accumulated are consistent with an orthorhombic D_{2h}^{14}(Pbcn) unit cell with four molecules located on C_2 sites. (auth)

27091 SPECTRA AND STRUCTURE OF CRYSTALLINE CYCLOPROPANE AND CYCLOPROPANE-D_6. McKean, D. C.; Duncan, J. L. (Univ. of Aberdeen, Scotland). J. Chem. Phys.; 52: 2803(1 Mar 1970).

Data on ir spectra of crystalline films of cyclopropane and cyclopropane-d_6 are compared with results by Bates, Sands, and Smith (J. Chem. Phys., 51: 101(1969)). (M.C.G.)

27092 TIME CORRELATIONS FROM INFRARED BANDS OF HDO. Wall, Theodore T. J. Chem. Phys.; 52: 2792-3(1 Mar 1970).

Time correlation functions (Fourier transforms) for ir bands of HDO are reported and compared with their Raman analogs. The functions are generally similar in size and shape and consistent with an unsymmetrical HDO molecule in the disordered environment of the liquid acting as scattering or absorbing center. (M.C.G.)

27093 ISOTOPIC EFFECTS ON THE THERMAL EXPANSION OF LITHIUM HYDRIDE. Anderson, J. L.; Nasise, J.; Philipson, K.; Pretzel, F. E. (Los Alamos Scientific Lab., N. Mex.). J. Phys. Chem. Solids; 31: 613-18(Apr 1970).

The effects of substitution of one isotope for another in the LiH molecule were investigated between −196 and 240°C. The isotope effect on lattice parameter, a_0, density, and coefficient of thermal expansion shows a definite trend whereby the lighter isotopes have larger lattice parameters and smaller coefficients of thermal expansion than the heavier isotopes. These effects are more pronounced when the lighter element is the one undergoing substitution. At the lower temperature the effect is relatively large but diminishes at the higher temperature. It is demonstrated that the lattice parameter for the isotopic lithium hydrides can, at any temperature, be related by the linear expression $a_0 = A\mu^{-\frac{1}{2}} + B$. These isotopic effects are discussed within the framework of the theories of Ubbelohde (1935) and London (1958). (auth) (UK)

27094 DIRECT DETERMINATION OF THE FORMAL POTENTIAL OF THE Am(IV)–Am(III) AND Am(VI)–Am(V) COUPLES IN PHOSPHORIC ACID. Yanir, E. (Soreq Nuclear Research Centre, Yavne, Israel); Givon, M.; Marcus, Y. Inorg. Nucl. Chem. Lett.; 6: 415-19(Apr 1970).

Americium(IV) has recently been obtained at high concentrations of phosphoric acid in which americium(III) is also soluble, hence the formal potential of the Am(IV)/Am(III) couple can be measured in this medium. Below about 4.5M phosphoric acid, the coexistence of americium(VI) and (V) permits the measurement of the formal potential of the Am(VI)/Am(V) couple. The formal potentials E_f, in volts, were calculated according to the equation: $E_f = E + E_r - E_j - 0.06 \log [\text{Am (ox)}]/[\text{Am (red)}]$ where E is the measured EMF and $(E_r - E_j)$ is the potential of the reference electrode and the liquid junction. The difference between the formal and the standard potential is disucssed. (UK)

27095 DOUBLE SHELL STRUCTURE OF THE PERIODIC SYSTEM OF THE ELEMENTS. Neubert, D. (Physikalisch-Technische Bundesanstalt, Berlin). Z. Naturforsch.; 25a: 210-17(Feb 1970).

A new periodic system of the elements (PSE) is proposed that exhibits symmetry properties not apparent in the conventional arrangement of the elements. By discussing the solutions of the nonrelativistic Schroedinger equation for the Coulomb problem, it is shown that the PSE might be based on the filling of only four Coulomb shells as compared to the partial filling of up to eight shells in the conventional classification. On the other hand, the multiplicity of the states in the PSE appears to be four as compared to two due to spin in the hydrogen spectrum. A transformation of the PSE spectrum into the hydrogen spectrum is possible by a rotation in quantum number space. (auth)

27096 RATE-DETERMINING STEP IN THE DECARBOXYLATION OF 2,4-DIHYDROXYBENZOIC ACID IN MASSIVE CONCENTRATIONS OF AQUEOUS HYDROCHLORIC ACID. Willi, A. V.; Cho, M. H.; Won, C. M. (Columbia Univ., New York). Helv. Chim. Acta; 53: 663-8(20 Apr 1970). (In German).

The decarboxylation kinetics of 2,4-dihydroxybenzoic acid were studied in 0.1 to 8 N aqueous HCl at 50°. At low HCl concentrations, the observed first order rate constant, k, increases with increasing acidity of the solution. In solutions with 3.5 to 6 N HCl, k remains constant. The D_2O solvent isotope effect decreases from $k_{H_2O}/k_{D_2O} = 2.0$ in 1N HCl to 1.3 in 5N HCl, and it remains unchanged at 1.3 if the HCl concentration is increased further to 8N. It is concluded that an increase of the acidity of the solution causes a change of the rate determining step from slow proton transfer to rate limiting C−C bond cleavage. (auth)

27097 THIN-LAYER CHROMATOGRAPHY AS AN AID IN RADIOCHEMISTRY. PART 4. SEPARATION OF ^{113}Sn FROM ^{113m}In. Seiler, H.; Seiler, M. (Univ., Basel). Helv. Chim. Acta; 53: 601-4(20 Apr 1970). (In German).

Thin-layer chromatography was applied to the separation of ^{113m}In from ^{113}Sn. Different factors influencing migration and separation of the ions are investigated. The method can be used for the examination of the purity of isolated ^{113m}In solutions. (auth)

27098 ORDINARY WEIGHING AND DENSITY DETERMINATION. Dykes, F. W.; Rein, J. E. (National Reactor Testing Station, Idaho Falls, Idaho). Progr. Nucl. Energy, Ser. IX; 10: 11-34(1970).

It is emphasized that remote weighing is rarely as easily accomplished as conventional weighing. Even though the introduction of the single pan substitution type of balance has greatly simplified remote weighing, achievement of satisfactory results still requires careful consideration of all aspects of a particular situation. The standard deviation of glove box weighings, for example, has been reported to be four times as great as that for conventional weighings, and because hot cell manipulations are generally more involved than glove box operations weighing errors can in these cases be expected to be even larger. Measurement of the density of solid radioactive samples is one of the major applications of remote weighing techniques. The subject is discussed under the following headings: basic considerations; special considerations (radiation effects; corrosion damage; ventilation effects; operational techniques); determination of weight (pilot plant and production installations; in-cell installations; exterior side-mounted installations; exterior top-mounted installations; special purpose installations); determination of density (true density of solids – hydrostatic technique, pycnometric technique, miscellaneous techniques; bulk density of solids; density of liquids – falling drop technique, balanced column technique, electromagnetic technique, pycnometric technique, float and sink technique). 109 references. (UK)

Radiation and Nuclear Chemistry

Refer also to abstracts 26970, 27044, 27058, 27065, 28413, and 28731.

27099 (AD-698037) THE DEVELOPMENT OF A PHOTOTROPIC ANODIZED ALUMINUM FINISH RESPONSIVE TO GAMMA RADIATION. Browning, Myron E.; Burks, Teman L. (North Star Research and Development Inst., Minneapolis, Minn.). Jul 1967. Contract DA-44-009-AMC-1549(T). 79p. (W-90-F). CFSTI.

An investigation was conducted to establish a phototropic anodized aluminum finish sensitive to gamma radiation. A comprehensive literature search revealed a number of candidate phototropic materials but very little information about gamma radiation response. Because early trials indicated that each candidate phototropic system possessed different dyeing characteristics for an anodic film, time-consuming trials with dyed anodic films were reduced by examining gamma radiation response to solutions of the phototropic materials. Color response could be detected in some systems at radiation levels as low as 20,000 roentgens depending on the dye concentration. Further studies disclosed three systems that have favorable color response to gamma radiation. These included certain triarylmethane dyes, a thiazine dye system, and systems using pH-indicator dyes as dyes per se. Studies of these phototropic dyes revealed that special attention will be required in anodizing, dyeing, and sealing techniques to obtain the best radiation response for the coated specimens. (auth) (USGRDR)

27100 (AD-701946) INVESTIGATION OF THE RADIOCHEMICAL SENSITIZATION EFFECT IN RUBBER. Kozlov, V. T.; Kaplunov, M. Ya.; Tarasova, Z. N.; Dogadkin, B. A. Translated from Vysokomol. Soedin., Ser. A; 10: 987-94(1968). 19p. (FSTC-HT-23-139-70). CFSTI.

Certain characteristic effects of a number of halogen-containing compounds, used earlier as radiochemical structuring sensitizers for rubbers of different structure were investigated. During radiolysis the sensitization effect in a number of halogen-containing organic substances increased from complex aromatic structures with a large number of atoms to linear structures without double bonds and with a small number of atoms. In the general case the sensitization effect is displayed by compounds containing atoms with high electronaffinity and possessing the ability to accept thermalized electrons. During radiolysis of appropriate sensitizers one of the most important processes is the splitting of halogen, where a significant contribution is made by the dissociative electron capture

reaction. It was hypothesized that the electron capture processes increase the probability of ion-molecular reactions of the primary ions with the formation of crosslinking. (auth) (USGRDR)

27101 (BNL–50211) MODERN ALCHEMY WITH ACCELERATORS. Brookhaven Lecture Series Number 82. Cumming, James B. (Brookhaven National Lab., Upton, N. Y.). 12 Mar 1969. 14p. Dep. CFSTI.

A general picture of nuclear reactions at high energies induced by protons is given. The mechanisms that play a role in such reactions are discussed. Experimental studies at GeV energies are described. Semiquantitative analysis of spallation and fission is considered. (M.C.G.)

27102 (CERN–70–5) EFFECTS OF RADIATION ON MATERIALS AND COMPONENTS. I. RADIATION EFFECTS ON POLYMERIC MATERIALS. II. RADIATION PROBLEMS RELATING TO HIGH-ENERGY ACCELERATORS. Van de Voorde, M. H. (European Organization for Nuclear Research, Geneva (Switzerland)). 26 Feb 1970. 52p. Dep. CFSTI (U. S. Sales Only).

Topics covered include: radioinduced phenomena in polymeric materials; factors that influence radiation effects on polymers; changes in mechanical, electrical, and physical properties of polymers as the result of radiation; radiation resistance of polymeric materials; dose levels around high-energy accelerators; and radiation resistance of materials and components. (149 references) (M.C.G.)

27103 (CERN–70–10) ACTION OF IONIZING RADIATION ON EPOXY RESINS. Van de Voorde, M. H. (European Organization for Nuclear Research, Geneva (Switzerland)). 19 Mar 1970. 97p. (In French). Dep. CFSTI (U. S. Sales Only).

The resistance of classical and experimental epoxy resins to irradiation was studied. The resistance to irradiation of epoxy resins of diverse compositions as well as the development of resins having a radioresistance that approaches that of certain ceramics are discussed. Sources of irradiation and the techniques of dosimetry used are described. The structures of certain epoxy resins and of hardeners are given. The preparation of these resins and their physical properties are described. The effects of radiation on epoxy resins, as well as conditions of irradiation, and suggested mechanisms for degradation of the irradiated resins are discussed. The relationship between chemical structure of the resins and their physical properties is evaluated. (115 references.) (J.G.B.)

27104 (ISS–69/12) ELECTRON PARAMAGNETIC RESONANCE IN POLYMETHYLMETHACRYLATE IRRADIATED BY ^{60}Co. Indovina, P. L.; Rosati, A. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 1 Mar 1969. 27p. (In Italian). Dep. CFSTI (U. S. Sales Only).

An EPR spectroscopic study performed on free radicals produced in sample of poly(methylmethacrylate) irradiated with γ rays from ^{60}Co is described. The splitting factor was measured at different frequencies and the time dependence of the parameters of the EPR signal was studied; from this it was concluded that in the irradiated polymer only one type of free radical is formed. An explanation is given of the observed spectrum in terms of the molecular conformation of the radical. (auth)

27105 (JUL–625–RC) LIGAND RECOIL AND SOLID STATE EXCHANGE REACTIONS IN HEXAHALO-COMPLEXES OF Re(IV) AND Rh(III). Bell, R.; Roessler, K.; Stoecklin, G.; Upadhyay, S. R. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Radiochemie). Nov 1969. 48p. (CONF-690719–1). Dep. CFSTI (U. S. Sales Only).

From International Symposium on Chemical Effects of Nuclear Transformations, Cambridge, England.

The chemical effects of (n,γ) and (n,2n) reactions on ligand halogen atoms were studied in hexahalo-complexes of the type $M_2[ReX_6]$ (M = Na, K, Rb, NH_4; X = F, Cl, Br, I) and $K_2[RhCl_6]$. Compared to the recoil behavior of the central atom, that of the ligand is considerably simpler, radiohalide and monosubstituted parent compound being the only products observed. For a given complex the type of nuclear reaction had no influence on the radiohalide yield. Information on the retention-forming processes was obtained from intermolecular competition experiments in mixed crystals $K_2[ReCl_6]/K_2[ReBr_6]$ (1:1). It could be shown by high-voltage electrophoresis that the recoil bromine appears in only three products: the free halide $^*Br^-$ (12%), and the monosubstituted complexes, $[ReBr_5{}^*Br]^{2-}$ (50%) and $[ReCl_5{}^*Br]^{2-}$ (30%); only negligible amounts of other mixed complexes were formed (each <2%). The isothermal annealing of neutron irradiated $K_2[ReCl_6]$ and $K_2[ReBr_6]$ at 80, 120, 160 and 200°C results in a decrease in the free halide yield (increase in retention), reaching temperature-dependent plateaus. The solid-state exchange followed first order kinetics, reaching temperature-dependent plateaus. For a given complex the velocity constants decreased from the chloride to the iodide dopants. For a given dopant the exchange was faster in the hexabromo- than in the hexachlororbenates, and in $K_2[RhCl_6]$ faster than in $K_2[ReCl_6]$. The results are explained on the basis of a nucleophilic substitution mechanism in which X^--ions react with a ligand vacancy, acting as a quasi positive hole. As a possible transport mechanism a ligand vacancy migration is proposed. A remarkable agreement between the solid state exchange and the annealing of the recoil halogens in corresponding systems was observed with respect to the velocity constants and the activation energies, indicating a similar mechanism in both cases. It was concluded that annealing after ligand recoil in hexahalo-complexes of Re(IV) and Rh(III) proceeds via the postulated solid state exchange mechanism, involving X^- ions. Useful application of the studies on ligand recoil in hexahalorhenates and -rhodates is the preparation of practically carrier-free ^{18}F, ^{34,38}Cl and ^{82}Br. (auth)

27106 (NP–18207) REPORT ON THE WORK OF THE INSTITUTE OF NUCLEAR SCIENCES. Progress Report No. 12, July–December 1968. (Institute of Nuclear Sciences, Lower Hutt (New Zealand)). 44p. (INS–344; A.E.C.–322). Dep. CFSTI (U. S. Sales Only).

Research progress is reported on nuclear physics, radiation chemistry, isotope geochemistry, radioactive dating and fallout, isotope applications, and instrumentation. (M.C.G.)

27107 (NYO–4000–2) GAMMA-EMITTING ANALOGS OF BIOLOGICALLY ACTIVE COMPOUNDS. Progress Report. (Roswell Park Memorial Inst., Buffalo, N. Y. Dept. of Nuclear Medicine). Apr 1970. Contract AT(30–1)–4000. 5p. Dep. CFSTI.

Detailed analysis of the products of ^{18}F recoil labeling of fluorobenzoic acid showed that none of the organic yield was in the desired compound. Recoil labeling was put aside temporarily and ^{18}F exchange reactions in solution and on gas chromatographic columns are being investigated. (auth)

27108 (RRL–2310–296) QUARTERLY REPORT [ON CHEMISTRY], JANUARY 1, 1970–MARCH 31, 1970. Fundamental Research No. 6041. (Mellon Inst., Pittsburgh, Pa. Radiation Research Labs.). 10 Apr 1970. Contract AT(30–1)–2310. 17p. Dep. CFSTI.

Research progress is reported on: radiation chemistry of $CFCl_3$, CF_2Cl_2, and CF_3Cl in dilute aqueous solutions; steady-state ESR measurement of the rate constant for the reaction of H atoms in aqueous solution; reactions of nitriles with e^-_{aq} and H; carbon coupling constants in acid radicals; ESR studies of fluorinated silyl radicals; electron trapping in the crystalline state of heterocyclic compounds with large dipole moments; radiation chemistry of viscous hydrocarbons; electric field effects on the radiolysis of liquid hydrocarbons; electron reactions in the gas phase; and electrolyte and micellar effects on the rates of decomposition of Meisenheimer complexes. (M.C.G.)

27109 (UCD–34–P–158–X–1) RECOIL STUDIES IN CHEMICAL DYNAMICS. Section A. Progress Report, January 1, 1968–December 31, 1968. (California Univ., Davis. Dept. of Chemistry). 11p. Dep. CFSTI.

The 1,1,1-trifluoroethane molecule was studied with both recoil ^{18}F and tritium. It was found that recoil ^{18}F reacts at much higher energies than recoil tritium. Reactions of recoil ^{18}F with cyclo-C_4F_8 and cyclo-C_3F_6 were investigated. Recoil studies with perfluoroalkanes demonstrated again that no F for F abstraction takes place. The ^{18}F for H abstraction reaction was studied. (M.C.G.)

27110 (UCRL–19335) THE CHEMICAL INTERACTIONS OF ACCELERATED ^{14}C IONS AND ATOMS WITH BENZENE. Lin, Tz-Hong (California Univ., Berkeley. Lawrence Radiation Lab.). Oct 1969. Contract W-7405-eng-48. 215p. Dep. CFSTI. Thesis.

Solid benzene at –196°C was irradiated with monoenergetic beams of $^{14}C^+$ ions and atoms with kinetic energy ranging from 5 eV to 15 keV. About 28% of the ions produced in the target benzene were identified as ^{14}C-labeled benzene, toluene, cycloheptatriene, phenylacetylene, styrene, biphenyl, diphenylmethane, phenylcycloheptatriene, benzaldehyde, tropone, phenol, and n-C_3–C_7 unsaturated alkylbenzenes. The nature of the reactions involved was investigated by total degradations of toluene; partial degradations of toluene (from 5- to 5000-eV irradiations) and benzaldehyde (from 15- to 5000-eV irradiations); and partial degradations of phenylacetylene, biphenyl, diphenylmethane, and phenylcycloheptatriene from a 5000-eV irradiation. The mechanisms for the product formations were interpreted in terms of the intermediate carbenes and radicals resulting from the C–H and C=C bond insertions of hot $C(^3P)$, $C(^1D)$, and $C(^1S)$. These intermediates were evidenced by the presence of benzaldehyde, tro-

pone, and phenol, which could result from the interactions of such intermediates with oxygen from an unknown source. The dependence of the radiochemical yields of the products upon the energy of the irradiating $^{14}C^{+}$ ions was consistent with these hypotheses. It was concluded that, in the accelerated C-benzene system, the hot and thermal $C(^{1}S)$ species react similarly. However, the reactions of hot $C(^{3}P)$ and $C(^{1}D)$ are different from that of the thermal counterparts. (auth)

27111 (UCRL-19504) REDUCTIVE DEAMINATION IN THE RADIOLYSIS OF OLIGOPEPTIDES IN AQUEOUS SOLUTION AND IN THE SOLID STATE. Bennett-Corniea, Winifred; Sokol, Harvey A.; Garrison, Warren M. (California Univ., Berkeley. Lawrence Radiation Lab.). Jan 1970. Contract W-7405-eng-48. 11p. (CONF-700310-1). Dep. CFSTI.

From 18th Annual Meeting of the Radiation Research Society, Dallas, Tex.

The role of reductive deamination in the γ radiolysis of the di- and tripeptide derivatives of glycine and alanine was investigated. The evidence is that in these systems the peptide linkage represents the effective trapping center: $e^{-} + NH_3^{+}CHRCONHCHR_2 \rightarrow (NH_3^{+}CHRC(O^{-})NHCHR_2) \rightarrow NH_3 + \dot{C}HRCONHCHR_2$. In the γ radiolysis of dilute, O_2-free solutions of glycylglycine and alanylalanine $G(NH_3)_{free} \approx G(\text{acylamino acid}) \approx 3 \approx G_{e^-}$ was obtained. The same products in essentially the same yield were also obtained in the γ radiolysis of these dipeptides in the solid state. The tripeptide derivatives show analogous reactions. A detailed comparative analysis of the radiation chemistry of the amino acids, glycine and alanine, and their respective peptide derivatives is given. (auth)

27112 LOW-TEMPERATURE RADIOLYSIS OF ALIPHATIC SULFIDES. Nanobashvili, E. M.; Panchvidze, M. V.; Dapkviashvili, A. G.; Khidesheli, G. I. (Inst. of Inorganic Chemistry and Electrochemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 57: 81-4(Jan 1970). (In Russian).

Primary products of low-temperature radiolysis of aliphatic sulfides were identified and their radiation yields measured. Yields of molecular hydrogen were determined by the mass-spectrometry method. On the basis of the data obtained the mechanism of low-temperature radiolysis of sulfides is discussed. (auth)

27113 INVESTIGATIONS ON THE SZILARD-CHALMERS EFFECT IN PHENYLANTIMONY COMPOUNDS. PART 2. THE ISOTOPE EFFECT IN TRIPHENYLSTIBINE. Grossmann, G.; Krabbes, G. (Technische Univ., Dresden). Isotopenpraxis; 6: 49-52(Feb 1970). (In German).

Triphenylstibine was irradiated at different neutron fluxes, gamma intensity and temperatures in a vacuum or in the presence of air. The distribution of radioactive antimony on products with different number of phenyl groups per Sb atom was determined. In these products the relative rate of isotopes ^{122}Sb and ^{124}Sb formed during the (n, γ) reaction was determined by means of gamma spectroscopy. In relation to the conditions of irradiation an isotope effect was observed. The influence of different energy and charge of the recoil atoms is discussed. Proceeding from the experimental results, it was concluded that the observed isotope effect is caused by transitions in the capture gamma spectrum. (auth)

27114 LUMINESCENCE IN HIGH-ENERGY-IRRADIATED ALKANES AT LOW TEMPERATURE. Burton, Milton; Funabashi, Koichi (Univ. of Notre Dame, Ind.). pp 153-81 of Organic Solid State Chemistry. /Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969). (COO-38-588).

From International Symposium on Organic Solid State Chemistry, Upton, N. Y. See CONF-680333.

High-energy bombardment is well-known to produce luminescence in condensed systems that contain suitable scintillators. Such light emission was observed for weak scintillators like benzene in sufficiently dilute solutions in aliphatic hydrocarbons and, more recently, even in pure liquid benzene but not in pure liquid alkanes. However, it has been found that when suitable alkanes are reduced to sufficiently low temperature (e.g., 77°K), irradiation with ^{60}Co γ radiation produces a persistent luminescence, the decay curves of which show peculiar behavior characteristics. Although luminescence can be induced in the lower alkanes by irradiation of polycrystalline material at sufficiently low temperature, it appears only when the temperature is raised to certain definite temperatures characteristic of each of the alkanes. Some of these temperatures correspond to known transition points; others may correspond to other solid state changes. The recent work and interpretations of Funabashi, Lang, and Janssen are reviewed. (auth)

27115 PARAMAGNETIC RELAXATION OF TRAPPED ELECTRONS IN GAMMA-IRRADIATED ORGANIC GLASSES. Chen, D. H.; Kevan, Larry (Univ. of Kansas, Lawrence). pp 183-96 of Organic Solid State Chemistry. /Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969). (COO-1528-25).

From International Symposium on Organic Solid State Chemistry, Upton, N. Y. See CONF-680333.

Paramagnetic relaxation characteristics of trapped electrons in γ-irradiated glassy methanol and methyltetrahydrofuran (MTHF) at 77°K were studied by power saturation techniques. The spin-spin relaxation time is constant with radiation dose at low doses and decreases at higher doses. Together with data on the total spin concentration the results are interpreted in terms of a "spur" model in which the initial spatial distribution of radiation-produced, trapped electrons and radicals is nonuniform. According to this model the spur radius is about 34 Å in methanol and 43 Å in MTHF. These radii compare with 30 Å for trapped electrons in alkaline ice. The radius within which electrons are trapped appears to increase with decreasing polarity of the matrix. (auth)

27116 ESR OF RADICALS PRODUCED IN ^{60}Co GAMMA-IRRADIATED POLYSTYRENE. Harrah, L. A. (Sandia Lab., Albuquerque, N. Mex.). pp 197-210 of Organic Solid State Chemistry. /Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From International Symposium on Organic Solid State Chemistry, Upton, N. Y. See CONF-680333.

The ESR spectra of radicals produced in ^{60}Co γ-irradiated polystyrene were studied for doses ranging from 1 to 700 Mrad. At least three distinct radical species are observed to occur in this dose range. The observed 100-eV yield of radicals for 25°C radiolysis is 0.102 ± 0.005 and is approximately ¼ of the previously reported value. The observed spectrum of the species produced at low doses was previously reported and interpreted as the disubstituted benzyl radical. The yield for this radical is estimated to be 0.09/100 eV. The second species, giving a single broad line at g = 2.002, formed with a yield of 0.012, is the most thermally stable species and may involve a crosslink center. A third radical species is observed at intermediate doses (>5 Mrad) and is attributed to the chain radical formed by loss of a β-hydrogen. The observed yield of this radical is 0.002/100 eV deposited. All 3 species are observed to decay isothermally at temperatures of ~55°C with the crosslink species having the greatest stability and the β radical the least. Exposure to oxygen causes the irreversible bleaching of all 3 species with the same rate. These data are interpreted in terms of the mechanisms of crosslinking, scission, and post irradiative oxidation of polystyrene. (auth)

27117 REACTIONS OF GASES WITH IRRADIATED ORGANIC SOLIDS. II. REACTIONS OF PROPIONAMIDE, n-BUTYRAMIDE, ISOBUTYRAMIDE, AND STEARAMIDE WITH OXYGEN AND NITRIC OXIDE. Faucitano, A.; Perotti, A.; Adler, G. (Brookhaven National Lab., Upton, N. Y.). pp 297-321 of Organic Solid State Chemistry. /Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From International Symposium on Organic Solid State Chemistry, Upton, N. Y. See CONF-680333.

The reactions of irradiated propionamide, n-butyramide, isobutyramide, valeramide, and stearamide with oxygen, nitric oxide, and sulfur dioxide were studied. Evidence was obtained from x-ray diffraction measurements and analytical data that the gases diffuse into the crystalline lattice of the amides reaching the radical sites and initiating chain reactions, which are influenced by the rate of diffusion and the crystal structure of the host compound. With oxygen, the first step is the formation of peroxyradicals; the reaction is then propagated by a hydrogen abstraction mechanism with formation of hydroperoxides. The reaction of nitric oxide is not yet fully understood; evidence from the EPR measurements was obtained of the formation of iminoxyradicals and of the existence of the equilibrium reaction between iminoxyradicals and nitric oxide. Sulfur dioxide adds to the original radicals giving sulfinic radicals, which propagate a chain reaction in which further sulfur dioxide is consumed. (auth)

27118 REACTIONS OF GASES WITH IRRADIATED ORGANIC SOLIDS. III. REACTIONS OF PROPIONAMIDE, n-BUTYRAMIDE, ISOBUTYRAMIDE, METHACRYLAMIDE, VALERAMIDE, AND STEARAMIDE WITH SULFUR DIOXIDE. Perotti, A.; Faucitano, A.; Adler, G. (Brookhaven National Lab., Upton, N. Y.). pp 323-42 of Organic Solid State Chemistry. /Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From International Symposium on Organic Solid State Chemistry, Upton, N. Y. See CONF-680333.

The reactions of γ-irradiated propionamide, n-butyramide, isobutyramide, methacrylamide, valeramide, and stearamide

with SO_2 were studied by ESR spectroscopy, gas absorption measurements, and x-ray diffraction. Sulfur dioxide reacts with the radicals originally generated in the irradiated material to give sulphonyl radicals. These propagate in a chain reaction in which further SO_2 is absorbed. In some cases the original radicals can be recovered from the corresponding sulphonyl radicals. The mechanism of the reactions is discussed. (auth)

27119 SOME SOLID STATE ASPECTS OF VINYL POLYMERIZATION IN ORGANIC CRYSTALS. Adler, G. (Brookhaven National Lab., Upton, N. Y.). pp 361-82 of Organic Solid State Chemistry. /Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From International Symposium on Organic Solid State Chemistry, Upton, N. Y. See CONF-680333.

By using the polymerization of acrylamide as an example, it is shown that solid-state polymerization is in general just a special case of organic solid-state reactions. Insofar as the solid-state aspects of the reaction are concerned, the reaction shows the expected behavior of an ordinary solid state reaction except that certain problems are exaggerated because of the large size of the product molecules involved and the larger number of possible configurations the molecule may have. The reaction goes by a two phase mechanism with the polymer in general nucleating at a defect site. The product is noncrystalline because of the mismatch in geometry between the product molecule and parent molecule. The fact that the reaction mostly occurs at the interface between monomer and polymer where the reacting molecule cannot easily flip over probably also contributes to the frequent atacticity of the product. Annealing and recrystallization are factors which probably influence the over-all rate of reaction. The large molecular size of the product and the frequently disordered nature of the product phase polymerizations allow the use of some rather simple techniques in the study of solid-state polymerizations making these good model systems for the study of some solid-state problems. (auth)

27120 POSITRON ANNIHILATION IN IRRADIATED ORGANIC CRYSTALS. Tabata, Y.; Ito, Y.; Oshima, K. (Tokyo Univ.). pp 417-34 of Organic Solid State Chemistry. /Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From International Symposium on Organic Solid State Chemistry, Upton, N. Y. See CONF-680333.

It is well known that "positron e^+" interacts with matter and forms a positronium ($e^+ - e^-$). Both the probability of the positronium formation and the lifetime of positronium are profoundly affected not only by the physical state of molecular substances, such as amount of defects, crystallinity, the size and other qualities of crystals, but also by the presence of excited species, such as ions, radicals and other excited species, produced in the system. Therefore, one can follow solid-state reactions by the measurement of lifetime of positronium and the probability of the formation in the reaction system without any degradative analysis. By applying this method to the radioinduced reaction in the organic crystalline state, polymerization of several monomers such as acrylonitrile, methacrylonitrile, acetaldehyde, and N-vinylcarbazole, in the crystalline state was studied and is reported for the latter two. In the initial stage of polymerization of acetaldehyde at −196°C, the lifetime increased with the irradiation dose, however, the lifetime decreased with the dose for further irradiation after the saturation of polymer yield. It was confirmed that the polymerization takes place at −196°C, probably under irradiation. In the polymerization of N-vinylcarbazole both the lifetime, τ_2, and the amounts of the τ_2-component, I_2, did not change during the first induction period. This suggests that in the period, the crystal structure does not change by irradiation and the accumulated active species are not enough to give any influence to the positronium formation. In the second induction period, τ_2 increased with irradiation time and I_2 decreased with irradiation time. The rapid increase of τ_2 may be due not only to the polymer formation, but also to the distortion of crystalline lattice by nucleation process; since the polymer formation remains only in several percent in the region. The decrease in I_2 in the period can be explained by postulating the formation of positron compounds. The positron compounds may be formed by addition of positron to monomer radicals or monomers distorted by the nucleation process. From these experiments, it was concluded that the variation of positron lifetime spectrum by irradiation gives useful information about the mechanism of solid-state polymerization. (auth)

27121 SOLID STATE POLYMERIZATION UNDER HIGH PRESSURE. Tabata, Y.; Shu, S.; Oshima, K. (Tokyo Univ.). pp 435-52 of Organic Solid State Chemistry. /Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From International Symposium on Organic Solid State Chemistry, Upton, N. Y. See CONF-680333.

Pressure-induced solid-state polymerization of acrylamide and radioinduced solid-state polymerization of three different types of monomers under high pressure are reported. Polymerization of solid acrylamide can be initiated by high pressure ranging from 20,000 to 150,000 atm. The contribution of pressure effect to the initiation and the propagation reactions is discussed. Radioinduced solid-state reactions in several radical-type polymerization systems were studied under pressure up to 6,000 atm. Only the propagation reaction was affected by applied pressure, and the reaction in the crystal matrices was suppressed, while the reaction in the amorphous matrices was accelerated by pressure. Polymerization of several monomers, such as acrylonitrile, methacrylonitrile, at low temperatures was studied under high pressure up to 7,000 atm. From these studies, it was shown that the polymerization of acrylontrile can take place without an appreciable change of the volume at very low temperatures below the transition point at about −130°C, and that the polymerization cannot take place in a definite temperature region, under a high pressure, from the melting point at the pressure to a transition point at about −100°C at the same pressure, indicating that a change of crystal structure by the phase transition gives an extremely large influence to the reactivity of monomer crystals. Polymerization of cyclic monomers such as trioxane, diketene, β-propiolactone and propylene oxide, was investigated. From the investigation, it was observed that the polymerization of diketene and β-propiolactone can be accelerated by applying pressure, while the polymerization of trioxane is retarded by applying pressure. The pressure effects on solid-state reactions were compared among three different types of polymerization. (auth)

27122 COPOLYMERIZATION BY GAMMA-IRRADIATION OF EUTECTIC MIXTURES. Kearney, J. J.; Herz, J. H.; Stannett, V. T.; Turner, D. T. (Research Triangle Inst., Research Triangle Park, N. C.). pp 485-501 of Organic Solid State Chemistry. /Adler, George (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

From International Symposium on Organic Solid State Chemistry, Upton, N. Y. See CONF-680333.

N-Vinylcarbazole and N-phenylacrylamide (33%) form a eutectic mixture with a melting point of 61°C. Exposure of this mixture at 55°C to γ rays can result in a yield of copolymer as high as 60%. Thermogravimetric analysis indicates a random rather than a block copolymer. These findings would seem to imply a system in which the two monomer units are intimately mixed and so would appear inconsistent with the view that the eutectic comprises separate crystals of each monomer. The findings can be explained more plausibly as being due to copolymerization in a glass and this was borne out by examination of the freshly solidified melt. The glassy state persisted for several hours at room temperature but then crystallization became noticeable. After several days large crystals (10 to 100 μ) had grown and when the system was irradiated in this state only a mixture of homopolymers was formed. (auth)

27123 RADIATION EFFECTS IN HOMOPOLYMERS AND DILUTE COPOLYMERS OF VINYL ACETATE. Yonetani, Kaoru; Graessley, William W. (Northwestern Univ., Evanston, Ill.). Polymer; 11: 222-36(Apr 1970).

The effects of small doses of gamma radiation on linear and branched poly(vinyl acetate) were investigated. When irradiated in vacuum at ambient temperature and then heated to 60°C after irradiation, the linear polymer increased in molecular weight with dose as expected for a random crosslinking process. The branched polymer underwent an additional reaction which appeared to involve rapid, preferential scission at approximately one sixth of the branch locations and which went to completion well before the gel point. Copolymers with trace amounts of α-methyl groups (0.1 to 10 groups per 1000 main chain carbon atoms) were prepared to simulate branching. These materials were highly sensitive to post-irradiation heat treatment compared with the homopolymers, although the numbers of trapped radicals were the same in all samples according to ESR measurements. Crosslinking rate increased with α-methyl content as judged by gel point values on annealed samples, reaching a maximum near three α-methyl groups per 1000 vinyl acetate units and decreasing again at high α-methyl contents. (auth) (UK)

27124 HYDROGEN AND ION YIELDS IN THE γ-RADIOLYSIS OF TETRAHYDROFURAN. Baxendale, J. H.; Beaumond, D.; Rodgers, M. A. J. (Univ. of Manchester, Eng.). Int. J. Radiat. Phys. Chem.; 2: 39-43(Apr 1970).

Gamma radiolysis of pure tetrahydrofuran gave $G(H_2) = 3.6$. This was reduced to 2.6 by electron scavengers and increased to 4.3 by addition of H_2O or D_2O. The latter gave $G(H_2) = 2.6$ and

G(HD) = 1.6. Sulphuric acid gave a further increase to $G(H_2)$ = 5.3. These observations were interpreted in terms of the reactions of three ionic species T_1^+, T_2^+, T_3^+ and solvated electrons, and were consistent with primary yields $G(e^-) = 2.7$, $G(T_1^+) = G(T_3^+) = 1.0$, $G(T_2^+) = 0.7$. (auth) (UK)

27125 RADIOLYTIC PROCESS IN POTASSIUM CHROMATE. Bancroft, G. M.; Dharmawardena, K. G.; Maddock, A. G. (Cambridge Univ., Eng.). Int. J. Radiat. Phys. Chem.; 2: 45-9 (Apr 1970).

Although potassium chromate is very resistant to gross radiolytic decomposition, ionizing irradiation does modify the infrared absorption spectrum of the salt, giving rise to a new band at 945 cm^{-1}. This radiolytic change was only slowly annealed by heating, but disappeared if the irradiated crystal was crushed to a powder. It is suggested that the process taking place may be represented as: $CrO_4^{3-} \rightarrow CrO_3 + O^{2-}$. (auth) (UK)

27126 STUDIES OF MECHANISM OF RADIATION CROSS-LINKING OF SOLID RUBBERS. Kozlov, V. T.; Gur'ev, M. V.; Evseev, A. G.; Kashevskaya, N. G.; Zubov, P. I. Vysokomol. Soedin., Ser. A; 12: 592-601(Mar 1970). (In Russian).

Radiation crosslinking and degradation of 22 compounds have been studied. Radiation yields of radicals, crosslinks, and ruptures at 77°K have been measured. In hydrocarbons, yields of radicals and crosslinks were affected by the molecular structure. Yield of crosslinks in nearly all cases exceeded one-half the radical yield, which was probably due to direct "under beam" rising of some of the crosslinks. The process occurred by a mechanism similar to rearrangement. The excitation involved neighboring atoms belonging to different molecules (during ~10^{-16} sec), the novel equillibrium positions being established at ~10^{-13} sec. Electron excitation was localized on the traps which may be due to impurities or closely situated segments of chains. As far as electron processes of crosslinking are related to transfer of excitation or "hole" they depend on the presence of radical atoms, which can accept excitation energy or charge. (auth)

27127 RADIATION INDUCED OXYHYDROLYSIS OF TETRACHLOROETHYLENE. Kowalski, Antoni; Perkowski, Jan; Kroh, Jerzy (Technical Univ., Lodz, Poland). Nukleonika; 14: 1152-63(1969).

The ^{60}Co γ-radioinduced oxyhydrolysis of tetrachloroethylene was investigated as a function of dose, dose rate, temperature, oxidizing agent and rate of oxygen flow. The process was carried out in open or closed circuit in the system: tetrachloroethylene–water–oxygen–or air. Apart from trichloroacetic acid certain side products as phosgene and diphosgene were determined. The reaction proceeding in the γ-field was compared with that initiated by uv rays. The uv experiments were performed by using air cooled, submerged uv-burner (Original Hanau 400 W). The rate of uv-energy absorption was 8.4×10^{19} eV hr^{-1} ml^{-1}. The γ-radiation experiments were carried out in a 0.20-kCi cobalt chamber allowing the dose rate to vary within the range 0.386 to 0.906 Mrad/hr. Under comparable reaction conditions the photochemical yield of trichloroacetic acid was 450 molecules/100 eV, whereas the radiation yield at a dose rate of 0.906 Mrad/hr equaled ca 9000. Comparison of the photochemically and radio-induced oxyhydrolysis indicated that the latter is more adequate for further industrial applications. (auth)

27128 THE TEMPERATURE DEPENDENCE OF DECOMPOSITION AND POLYMERIZATION IN THE γ IRRADIATION OF POLYETHYLENE OXIDE. Schnabel, Wolfram (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Makromol. Chem.; 131: 287-93(1970). (In German).

Three samples of poly(ethylene oxide) (P_n between 100 and 200) have been γ irradiated at various temperatures in the pre-gel region. Changes in number and average molecular weight have been determined and therefrom 100-eV-yields of crosslinking G(X) and main chain scission G(S) calculated. At room temperature G(S) amounted to 2.0 and G(X) to 1.8. Whereas crosslinking and degradation were only slightly enhanced with increasing temperature below the melting point, a significant increase to G(S) = 4.2 and G(X) = 4.0 occurred at the transition to liquid state. Above the melting point both G(S) and G(X) were independent of temperature up to the highest temperature (120°C). The increase at the phase transition was considered to be due to the higher mobility of the macromolecules in the liquid state in conjunction with a diminution of cage recombination of geminate macroradicals produced by main chain scissions. At high temperatures the H-atom-abstraction from intact macromolecules by end group macroradicals was favored. Thereafter additional side group macroradicals were formed. (auth)

27129 STRUCTURE OF ACTIVE SITES PRODUCED BY GAMMA-RAY IRRADIATION OF CELLULOSE ACETATE. Yasukawa, Tamio; Matsuzaki, Kei; Yamagishi, Masao (Tokyo Univ.). Makromol. Chem.; 131: 305-7(1970).

The ESR spectra of celiulose acetate irradiated at low temperature were examined. The samples were γ irradiated at 3.8×10^5 rad/hr for five hours in a liquid nitrogen bath. The results showed that nearly equal amounts of active sites are formed on acetyl groups and on cellulose skeleton, and the unpaired electron on cellulose skeleton is principally located at 6-C position in irradiated cellulose acetate. (P.C.H.)

27130 IONISATION MEASUREMENTS AND SOME IONIC REACTIONS IN GAS PHASE RADIOLYSIS. Huyton, D. W.; Woodward, T. W. (Univ. of Salford, Eng.). Radiat. Res. Rev.; 2: 205-34 (Mar 1970).

Energy absorption in gases is discussed with emphasis placed on molecular stopping power ratios, the determination of W values, and dosimetry. Studies on the effects of electron scavengers and applied fields on the radiolysis mechanism of systems where the molecule under investigation may react with electrons by dissociative attachment processes are reviewed. (95 references.) (J.G.B.)

27131 ANNEALING EFFECTS IN LOW TEMPERATURE REACTOR IRRADIATED CRYSTALLINE COBALTIC TRISETHYLENEDIAMINE NITRATE. Dimotakis, Paul N.; Papadopoulos, Basil P. (Democritos Nuclear Research Center, Athens). J. Inorg. Nucl. Chem.; 32: 1071-4(Apr 1970).

Both isothermal and linear tempering annealing of cobaltic trisethylenediamine nitrate, irradiated at liquid nitrogen temperature in a reactor, were studied. More precise isotherms confirmed the previously reported oscillation in the isotherms. These maxima and minima were more pronounced than those of samples irradiated at ambient temperature. Corresponding maxima and minima appeared sooner at higher temperatures of annealing, and this effect was more noticeable after low temperature irradiation. Linear tempering thermal annealing of low temperature irradiated material also gave curves containing maxima and minima. (auth) (UK)

27132 STUDY OF THE OXIDIZING DEGRADATION OF POLYOXYETHYLENE AT 25°C IN PRESENCE OF ^{18}O. Decker, Christian; Marchal, Jean (Centre National de la Recherche Scientifique, Strasbourg). Compt. Rend., Ser. C; 270: 990-3 (16 Mar 1970). (In French).

The auto-oxydegradation of polyoxyethylene observed at 25°C was studied in the presence of $^{18}O_2$ when initiated by γ irradiation of dilute solutions. This auto-oxydegradation could be explained by the monomolecular decomposition of the secondary peroxy radicals according to a mechanism with a hexagonal transition state. (France)

27133 ELECTRON CAPTURE PROCESSES IN THE RADIOLYSIS OF HYDROGEN CHLORIDE AND OF PROPANE + HYDROGEN CHLORIDE MIXTURES. Johnson, G. R. A.; Redpath, J. L. (Univ. of Newcastle-upon-Tyne, Eng.). Trans. Faraday Soc.; 66: 861-8(Apr 1970).

The depression of the H_2 yield from irradiated HCl gas by SF_6 was studied at different HCl concentrations. It was concluded that HCl reacts with thermal electrons, in competition with SF_6, by a process that is third order in HCl concentration. A mechanism is suggested for this process, which also explains the effect of HCl on the N_2 and H_2 yields in the radiolysis of $C_3H_8 + N_2O$ mixtures. (auth) (UK)

27134 GAMMA RADIOLYSIS OF DESAERATED LIQUID ISOPROPANOL AT ROOM TEMPERATURE. Gilles, Lucien; Sutton, Jack (Commissariat a l'Energie Atomique, Saclay, France). J. Chim. Phys.; 67: 128-38(Jan 1970). (In French).

The main products formed in the room temperature γ radiolysis of liquid isopropanol, and their respective yields, in molecules/100 eV, are: hydrogen 3.8, methane 1.6, acetone 3.4, acetaldehyde 1.1, and pinacol 0.3. These results give a material balance in good agreement with the formula of isopropanol and lead to a value for the decomposition yield of 5.3. The absence of 2,3-butanediol shows that the acetaldehyde cannot come from the dismutation of hydroxyethyl radicals. The variations of the hydrogen yield in the neutral medium with the concentration of added electron scavengers may be explained in terms of the model proposed by Freeman and Fayadh, which supposes the existence of spurs. The yield of solvated electrons diffusing into the bulk of the solution and also the ratios of rate constants for the reactions of the scavengers with the electrons may likewise be obtained on the basis of this model. Certain effects not forseen by this model may result from the capture of electrons, solvated or not, whose mode of disappearance in pure alcohol remains unknown. A yield of excited molecules of at least 2 may be distinguished, of which

80% lead to the production of molecular hydrogen and 20% to that of molecular methane and an ionization yield of 2.2. (France)

27135 CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS IN THE ALKALI CHLORIDES. PART II. ANALYTICAL PROBLEMS WITH ^{35}S. Kasrai, M.; Maddock, A. G. (Cambridge Univ., Eng.). J. Chem. Soc., A; No. 7, 1105-10(1970).

^{35}S released in an alkali chloride matrix is present in four chemically distinguishable forms. An analytical procedure for determining their proportions is described. Evidence is given that the four products, sulfide, thiocyanate, sulfite, and sulfate, separated in the process are derived from four different lattice entities. (auth) (UK)

27136 ACTIONS CHIMIQUES ET BIOLOGIQUES DES RADIATIONS. (The Chemical and Biological Actions of Radiations). Haissinsky, M. Treizieme Serie. Paris; Masson et Cie, Editeurs (1969). 240p. 65 F.

Four chapters are included, three of which have been abstracted separately for NSA. The remaining chapter includes a discussion on the hydrated electron in photochemistry. (J.G.B.)

For abstracts of individual chapters see: 27137–27139.

27137 RADIOLUMINESCENCE OF ORGANIC MATERIALS. Voltz, R. (Centre de Recherches Nucleaires, Strasbourg). pp 1-55 of Actions Chimiques et Biologiques des Radiations. /Haissinsky, M. Paris; Masson et Cie, Editeurs (1969). (In French).

Emphasis is placed on theoretical aspects in this review work on radioluminescence of organic materials. The nature and evolution of activation states in irradiated aromatic media are discussed. Kinetic studies in which the problems of intensity of the scintillation as well as its integrated intensity during a certain time interval are considered. The yield of radioluminescence and its variations as a function of the nature of particle charges are discussed. (109 references.) (J.G.B.)

27138 RADIATION CHEMISTRY OF FROZEN POLAR SYSTEMS. Kevan, Larry (Univ. of Kansas, Lawrence). pp 57-117 of Actions Chimiques et Biologiques des Radiations. /Haissinsky, M. Paris; Masson et Cie, Editeurs (1969).

The radiolysis of aqueous and alcoholic frozen systems is reviewed. Frozen matrices that can exist either as glasses or as polycrystals are discussed separately. Emphasis is placed on the identification and reactions of trapped intermediates. Gamma irradiation was studied in most cases, although results from photoionization and photolysis in frozen systems are also discussed. (J.G.B.)

27139 INDUSTRIAL APPLICATIONS OF RADIATION CHEMISTRY. Danno, Akibumi (Japan Atomic Energy Research Inst., Takasaki). pp 145-224 of Actions Chimiques et Biologiques des Radiations. /Haissinsky, M. Paris; Masson et Cie, Editeurs (1969).

Applications of high-energy radiation as a chemical tool in radiochemical processes are discussed. Methods, which in the near future might lead to technologically important processes, are cited. Examples include modification of plastics, radioinduced graft copolymerization, radioinduced polymerization and radioinduced synthesis of chemicals. An analysis of the economics of radiation processes is included. (102 references.) (J.G.B.)

27140 GELATION OF POLY(ETHYLENE OXIDE) SOLUTIONS BY GAMMA RADIATION: EFFECTS OF MOLECULAR WEIGHT AND IRRADIATION CONDITIONS. Van Brederode, R. A.; Rodriguez, F. (Cornell Univ., Ithaca, N. Y.). J. Appl. Polym. Sci.; 14: 979-87(Apr 1970).

Reticulation of a dilute aqueous solution of poly(ethylene oxide) in a ^{60}Co gamma-radiation field yielded a weak gel, which was characterized by its damped sinusoidal oscillation in a free-swinging torsion pendulum. A storage and a loss modulus were calculated from the log decrement and frequency of oscillation, and the cross-link density was obtained from the storage modulus using the kinetic equation of rubber elasticity. The number of cross-links added to the polymer per 100 eV energy absorbed in the polymer above and below the gel point and the fraction of gamma energy absorbed directly by the polymer were determined from the dose-to-gel and modulus data. The effects of oxygen on the cross-linking reaction and the temperature on the gel's mechanical properties were experimentally observed. (auth)

27141 RHEOLOGICAL PROPERTIES OF ELASTOMERS BASED ON CELLULOSE FIBERS. Nakamura, Y. (Agricultural Research Service, New Orleans); Arthur, Jett C. Jr.; Negishi, M.; Doi, K.; Kageyama, E.; Kudo, K. J. Appl. Polym. Sci.; 14: 929-51(Apr 1970).

Elastomers, based on cellulose fibers, were synthesized by grafting ethyl acrylate onto fibers preirradiated by a high-energy electron beam. The rheological properties and fine structure of the elastomers were investigated in order to determine factors in development of rubber-like elastomeric behavior. Mechanical properties of the elastomers depended on degree of polymerization of irradiated cellulose molecules, extent of grafting, and experimental methods of evaluation, particularly in varying environmental conditions, for example, in making measurements in air, water, or ethyl acetate. Glass transition temperatures of the elastomers were dependent on the environmental conditions of evaluation; stiffnesses of the elastomers leveled off at about 0°C; and in all environments, a rubber-like plateau was observed. Poly(ethyl acrylate) separated from the elastomers was not soluble in acetone. The mean molecular weight of the separated poly(ethyl acrylate) of the elastomer was determined in ethyl acetate by the equilibrium swelling method. It was concluded that cross-links existed in the elastomers. Electron microphotographs of cross sections of the elastomers, which exhibited rubber-like behavior, indicated that the fibrillar structure of the irradiated cellulose fibers formed a uniform network and that poly(ethyl acrylate) was uniformly distributed among the fibrils. (auth)

27142 EFFECTS OF MIXING STATES ON PHYSICAL PROPERTIES OF VULCANIZATES OF POLYBUTADIENE RUBBER–GENERAL PURPOSE POLYSTYRENE RESIN BLEND. Satake, K. (Asahi Chemical Industrial Co., Ltd., Kawasaki, Japan). J. Appl. Polym. Sci.; 14: 1007-17(Apr 1970).

The effects of the continuous phases of general purpose polystyrene resins upon the physical properties of the vulcanizates were studied using the polybutadiene rubber–general purpose polystyrene resin blend. Radiation cure was adopted so that a change of state during cure might be avoided. Some physical properties like hardness, modulus, elongation, permanent set, and resilience were much influenced by the existence of the continuous phases even if the polymer blend ratios were kept constant, whereas tensile strength at failure was mainly determined by the polymer blend ratio. The physical properties that belong to the former group were found to be controlled more strongly by the polymer that forms the continuous phase. (auth)

27143 OXIDES AND OXY-IONS OF THE NON-METALS. PART XI. ELECTRON SPIN RESONANCE STUDY OF THE BrO_3 RADICAL IN γ-IRRADIATED POTASSIUM BROMATE. Begum, Afrozi; Subramanian, S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; 918-21(1970).

The radical BrO_3, produced by γ-radiolysis of potassium bromate at 77°K was studied by ESR. At this temperature the magnetic parameters were: g_{11} 2.027, g_{22} 2.102 and g_{33} 2.076, and A_{11} 864, A_{22} 483, and A_{33} 483 G, and at ca 130°K, the rotating radical gave g_{av} 2.070 and A_{iso} 614 G. On further warming, BrO_3 was lost, leaving a resonance assignable to O_2^-. The calculated spin-density on the Br atom and the p/s ratio follow the trend predicted from the results of the isoelectronic species AsO_3^{2-}, PO_3^{2-}, SeO_3^-, SO_3^-, and ClO_3. BrO_3 is also found to be a product of γ-irradiation of frozen alkaline solutions of potassium bromate. (auth) (UK)

27144 LINEAR TEMPERING ANNEALING OF REACTOR IRRADIATED CRYSTALLINE CHEMICAL COMPOUNDS. Dimotakis, P. N.; Yavas, G. (Democritos Nuclear Research Centre, Athens). J. Inorg. Nucl. Chem.; 32: 1065-9(Apr 1970).

Linear tempering annealing consists of heating samples at a constant temperature gradient, and this technique was applied to neutron-irradiated crystalline cobaltic trisethylenediamine nitrate for a number of different temperature gradients. A family of curves was obtained containing maxima and minima and compared with a family of corresponding three-dimensional annealing isotherms. It was found that the surface formed by the linear tempering annealing curves did not coincide with the surface of the isothermal curves. The data obtained were compatible with the recombination kinetics of recoil atoms with their parent radicals being determined by consecutive recombination and decomposition reactions. (UK)

27145 INVESTIGATION ON THE RESISTANCE OF ANTHOCYANINE PIGMENTS TO RADIATION. PART I. EFFECT OF SOME FACTORS ACCELERATING AND INHIBITING THE RADIATIVE DEGRADATION OF PIGMENTS. Wilska-Jeszka, Jadwiga (Politechnika, Lodz, Poland). Nukleonika; 14: 973-86 (1969). (In Polish).

Radiation yields of the decomposition reaction of pelargonidine 3-mono-glycoside (3MGPg) and cyanidine 3-mono-glycoside (3MGCy) in gamma-irradiated (^{60}Co) water solutions were investigated. The effects of pH, alcohols, polyphenols, and metal ions were examined. It was found that $G_{(-3MGPg)}$ and $G_{(-3MGCy)}$ show

maxima at pH 3 to 4. The addition of methanol or ethanol increases the $G_{(-3MGFe)}$ whereas polyphenols and copper ions show an inhibiting effect. (auth)

27146 RADIATION-INDUCED ION–MOLECULE REACTIONS. Levy, Boris (to Mobil Oil Corp.). U. S. Patent 3,507,760. 21 Apr 1970. Filed 16 Jun 1964.

A method of producing radioinduced ion–molecule reactions comprises forming a gaseous mixture of the molecule reactant and ion reactant precursor and irradiating the mixture with ionizing radiation to ionize the molecule reactant, preferably absorbing in the latter a major portion of the absorbed radiation. The system CO–ethane, in which CO is the molecule reactant, is described as an illustration. (B.L.M.)

27147 ISOTOPE EFFECTS IN RECOIL TRITIUM REACTIONS WITH FLUOROFORM AND DEUTERIOFLUOROFORM. Smail, Thomas; Rowland, F. S. (Univ. of California, Irvine). Contract AT-(11-1)-34. J. Phys. Chem.; 74: 1859-65(30 Apr 1970).

The primary replacement isotope effect for the energetic substitution reactions $T^* + CHF_3 \rightarrow CTF_3 + H$ and $T^* + CDF_3 \rightarrow CTF_3 + D$ is $k_H/k_D = 1.35 \pm 0.05$, with little variation between liquid and gas phases. The higher yield for the replacement of H vs D is a mass effect reflecting the relative rapidity of response to changes in interatomic potentials during the interaction of tritium with fluoroform. The secondary hydrogen isotope effect for the substitution of T for F in CHF_3 vs CDF_3 is $k_H/k_D = 1.45 \pm 0.05$. The large magnitude of this isotope effect is consistent with individual relaxation of the H and D atoms during interaction of T with fluoroform as a controlling factor in the T for F substitution. The isotope effect is inconsistent with inertial postulates treating the CHF_2 and CDF_2 radicals as rotating entities. (auth)

27148 ELECTRON SPIN RESONANCE STUDIES ON γ-IRRADIATED FROZEN AQUEOUS SOLUTIONS OF SODIUM FORMATE. Nazhat, R. A.; Nazhat, N. B.; Moorthy, P. N.; Weiss, J. J. (Univ. of Newcastle upon Tyne, Eng.). J. Phys. Chem.; 74: 1901-5(30 Apr 1970).

γ-Irradiated frozen aqueous solutions of formate were investigated by ESR. OH radicals from the ice and HCO, HCOO, and CO_2^- from the formate were identified from a study of g factors and hfs of the ESR spectra. (Experiments were also carried out with deuterioformate and in D_2O matrices.) From the dependence of the spectra on solute concentration and the effects of different scavengers, possible mechanisms for the formation of these radicals were discussed. Some trapped electrons are also formed by the radiation, as indicated by the blue color of the irradiated matrices; these can be bleached by visible light. The strong signal from the CO_2^- radical ion did not allow direct observation of the ESR spectrum of the trapped electron. (auth)

27149 SEMICONTINUUM MODEL FOR THE HYDRATED ELECTRON. Fueki, Kenji (Nagoya Univ., Japan); Feng, Da-fei; Kevan, Larry. J. Phys. Chem.; 74: 1976-81(30 Apr 1970). COO–1528-38).

A semicontinuum model was developed for the hydrated electron. Long-range interactions are represented by a polarization potential and short-range attractive interactions are represented by a point dipole approximation. Energy levels as a function of cavity radius are calculated within a self-consistent field approximation. The optical transition energy is rather insensitive to different configurations of the water molecules in the first solvation shell around the electron. The observed optical absorption of the hydrated electron in both water with $D_s = 80$ and in ice at 77°K with $D_s = 3$ can be satisfactorily explained with this model for cavity radii near 1 Å. The calculated heat of solution and charge distribution of the hydrated electron with this cavity radius are also in good agreement with the experimental values. (auth)

27150 THE RADIATION CHEMISTRY OF POLYETHYLENE. X. KINETICS OF THE CONVERSION OF ALKYL TO ALLYL FREE RADICALS. Waterman, D. C.; Dole, Malcolm (Northwestern Univ., Evanston, Ill.). J. Phys. Chem.; 74: 1913-22 (30 Apr 1970). (COO–1088-36).

Evidence was found that alkyl free radicals which persist at room temperature after an electron beam irradiation at liquid nitrogen temperature quantitatively convert to allyl free radicals by reaction with trans-vinylene or vinyl double bonds. The decay of the alkyl radicals is accurately first order and is markedly catalyzed by molecular hydrogen. Whereas the catalyzed reaction rate constant has the order of magnitude expected on the basis of analogous gas-phase reactions, the rate constant for the uncatalyzed reaction is smaller than similar gas reactions by a factor of 10^7, due partly to a higher activation energy and partly also very probably to a greatly reduced frequency factor in the solid state. A small number of alkyl radicals regenerated from the allyl by ultraviolet irradiation at 77°K and which persist to room temperature have no measurable decay at room temperature in the absence of molecular hydrogen. In the presence of hydrogen they decay by a second-order process, but do not reform allyl radicals. At the present time no plausible explanation exists for this unexpected behavior. (auth)

27151 ULTRAVIOLET AND INFRARED STUDIES OF FREE RADICALS IN IRRADIATED POLYETHYLENE. Waterman, D. C.; Dole, M. (Northwestern Univ., Evanston, Ill.). J. Phys. Chem.; 74: 1906-12(30 Apr 1970). (COO–1088-35).

Electron spin resonance, infrared, and ultraviolet spectral measurements were made on the alkyl, allyl, and dienyl free radicals in electron beam-irradiated high-density polyethylene. G values and extinction coefficients were determined. Additional evidence for the assignment of the 215-nm band to the alkyl free radical, the 258-nm band to the allyl free radical, and the 943-cm^{-1} band to stabilized allyl and dienyl free radicals is given. At 77°K the growth of the allyl free radical is linear with dose up to at least 80 Mrads, but the allyl radicals, which are formed at room temperature subsequent to the irradiation at 77°K, approach a limiting concentration of about 0.02M. (auth)

27152 EXCITATION TRANSFER IN THE PULSE RADIOLYSIS OF NAPHTHALENE AND BENZOPHENONE SOLUTIONS. Holroyd, R. A. (Atomics International, Canoga Park, Calif. Brookhaven National Lab., Upton, N. Y.); Theard, L. M.; Peterson, F. C. J. Phys. Chem.; 74: 1895-1900(30 Apr 1970).

The nanosecond pulse radiolysis of solutions of 1,2-benzanthracene in liquid naphthalene at 100° and of anthracene in benzophenone at 30° was investigated. In both solutions solute molecules are not excited at the end of the pulse. After the pulse, excited solute molecules in singlet and triplet states are formed by excitation transfer from the solvent. Ions are not involved in the transfer. The transfer of triplet state energy from benzophenone solvent to anthracene solute was detected by observing that the rate of decay of the excited benzophenone triplet is equal to the rate of formation of anthracene triplets. The rate constant of triplet–triplet transfer in molten benzophenone at 30° is $(1.6 \pm 0.1) \times 10^9$ M^{-1} sec^{-1} and in molten naphthalene at 100° is 1.1×10^{10} M^{-1} sec^{-1}. In both solvents the rate of triplet transfer is diffusion controlled. Singlet–singlet transfer was also time resolved for a solution of benzanthracene in naphthalene by observing the fluorescence intensity which rose to a maximum 16 nsec after a 5-nsec pulse. Singlet energy transfer is an order of magnitude faster than triplet–triplet transfer in this solvent. (auth)

27153 FURTHER STUDIES ON THE PROPERTIES OF ELECTRONS TRAPPED IN GLASSY HYDROCARBONS. Ekstrom, A.; Suenram, R.; Willard, J. E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. J. Phys. Chem.; 74: 1888-94(30 Apr 1970).

The observation that the concentration of trapped electrons observable by infrared absorption and ESR in γ-irradiated hydrocarbon glasses at 77°K increases with increasing dose, passes through a maximum, and then falls to zero at ca. 2×10^{20} eV g^{-1} has been further confirmed. It was found that this phenomenon is not due to the reaction $H + e^- \rightarrow H^-$, previously suggested, but probably results from reaction of mobile electrons with trapped positive charge and radicals, and reaction of mobile positive charge with trapped electrons. Thermal annealing of γ-irradiated 3-methylpentane (3MP) at 90°K, which removes free radicals and electrons, regenerates the capacity of the matrix to trap electrons at 77°K. γ Irradiation of 3MP at 77°K produces at least three species which absorb in the near-uv region. The evidence suggests that these are olefins, alkyl radicals, and anions of alkyl radicals. The carbanion spectrum can be enhanced by photobleaching the infrared band of the trapped electrons, and the latter can be partially regenerated by photobleaching the absorption band of the carbanions. γ Irradiation of a matrix containing both 3MP and $n\text{-}C_3H_7OH$ produces two trapped electron spectra, one with λ_{max} at 1600 nm characteristic of trapping in the hydrocarbon environment and one with λ_{max} at 540 nm characteristic of the alcohol. Thermal annealing at 90°K transfers electrons from the hydrocarbon to the alcohol environment. Photobleaching with 540-nm radiation removes both electron populations while 1600-nm radiation removes only those in the hydrocarbon environment. In contrast to the hydride ion hypothesis, these results do not require the conclusion that the matrices contain only a limited number of electron trapping sites. (auth)

27154 CHEMICAL EFFECTS IN THIN FILMS OF 1-HEXENE AT 77°K DUE TO LOW-ENERGY ELECTRON IMPACT. Hunter, Linda M.; Matsushige, Toshiaki; Hamill, William H. (Univ. of

Notre Dame, Ind.). J. Phys. Chem.; 74: 1883-8(30 Apr 1970). (COO-38-700).

Thin films (~500 cm^2 × 700 Å) of 1-hexene at 77°K were bombarded by low-energy electrons and the products subsequently analyzed. At ~50 eV the yields of dimeric products per unit absorbed energy approximate those of conventional samples at the same temperature following ^{60}Co irradiation. Both C_{12} and fragmented hydrocarbons begin to form at ~3 eV, reach pronounced maxima at ~4 eV, then fall nearly to zero at ~8 eV, and nearly attain plateaus by ~20 eV. The peaks at low energy are attributed to triplet excitation of π electrons for dimerization and to triplet excitation of σ electrons for C—C scission. (auth)

27155 INFLUENCE OF pH UPON THE PHOTOLYSIS OF THE URANYL OXALATE ACTINOMETER SYSTEM. Heidt, Lawrence J.; Tregay, George W.; Middleton, Frederick A. Jr. (Massachusetts Inst. of Tech., Cambridge. Emmanuel Coll., Boston. Islamabad Univ., Pakistan). J. Phys. Chem.; 74: 1876-82(30 Apr 1970).

A study was made at 25° of the influence of pH upon the relative quantum yields for the consumption of oxalate and the production of carbon dioxide, carbon monoxide, and uranous ion by light of 254 nm absorbed by the uranyl oxalate actinometer system. The uranyl ion was at 0.01 F, the oxalate at 0.06 F, and initial pH was at 0 to 6. About 12% of the oxalate was decomposed. The quantum yields for the consumption of oxalate were found to be independent of the pH between 1 and 5 but to decrease outside this range. The reaction at all values of pH was found to consume acid. The moles of carbon dioxide produced in all forms (CO_2, H_2CO_3, HCO_3^-, CO_3^{2-}, and the uranyl carbonate complexes) per mole of oxalate consumed very nearly equalled unity at pH 0 to 5. The moles of carbon monoxide produced per mole of oxalate consumed were always less than unity; they decreased with increase in pH abruptly between pH 1 and 2, and became negligible above pH 3. The mole ratio of uranous ion produced to oxalate consumed increased slowly from about 0.03 between pH 1.5 and 4 to about 0.08 at pH 6. The mechanisms of the reactions are discussed. (auth)

27156 NEUTRON ACTIVATION OF AROMATIC SELENIUM AND TELLURIUM COMPOUNDS. Wheeler, O. H.; Gonzalez, C. L.; Lopez-Alonsor, H. (Puerto Rico Nuclear Center, Mayaguez). Int. J. Appl. Radiat. Isotop.; 21: 244-6(Apr 1970).

The investigation of radioactive products formed in the neutron activation of diphenyl selenide, diphenyl selenoxide (Ph_2SeO) and diphenyl selenone (Ph_2SeO_2) and a reinvestigation of diphenyltellurium are reported. (auth) (UK)

27157 PROCESS FOR ELECTROCOATING AND POLYMERIZING BY RADIATION. Turner, Allen H. (to Ford Motor Co.). U. S. Patent 3,501,390. 17 Mar 1970. Filed 3 Oct 1966.

A method of coating an electrically conductive article comprises passing the article through an electroplating bath containing an alpha-beta, olefinically unsaturated, coating material, at least a major portion of which is a carboxylic acid resin ionizable in aqueous solution of water-ionizable amino compound dispersed in an aqueous solution of the amino compound, providing a difference of electric potential between the workpiece and another electrode in contact with the bath to deposit the ionized resin on the workpiece, and polymerizing the coating by radiation. The workpiece is passed from the bath through a liquid seal into a controlled inert atmosphere and the freshly deposited coating is polymerized upon the surface by ionizing radiation. The polymerized coated piece is passed through a second liquid seal to the outside. (B.L.M.)

27158 RADIOLUMINESCENCE IN ORGANIC LIQUIDS. II. BASIS OF THE DELAYED COMPONENT IN BENZENE AND TOLUENE. Spurny, F. (Technical Univ., Prague). Collect. Czech. Chem. Commun.; 35: 565-75(Feb 1970).

The intensity of the radioluminescence of PBD (2-phenyl-5-(4-biphenyiyl)-1,3,4-oxadiazole) was studied in benzene, toluene, and their mixtures with cyclohexane and cyclohexene on excitation by α and β radiation. The delayed component of radioluminescence in these solvents was not caused by a bimolecular reaction of molecules of benzene or toluene in the lowest triplet excited states but rather by a bimolecular reaction of molecules of the fluorescence activator in the lowest triplet excited states. These states can be attained either through the action of subexcitation electrons or due to recombination of ions. The modes by which cyclohexane, cyclohexene, and atmospheric oxygen affect the intensity of radioluminescence are discussed. (auth)

27159 ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED SINGLE CRYSTALS OF DIHYDROTHYMINE. Henriksen, Thormod; Snipes, Wallace (Univ. of California, Berkeley). J. Chem. Phys.; 52: 1997-2000(15 Feb 1970).

Both the 5-thymyl radical and the 6-thymyl radical are formed when dihydrothymine is irradiated at room temperature. The 6-thymyl radical was analyzed in detail by use of electron spin resonance (ESR) spectroscopy. Principal values for the spectroscopic splitting tensor are $g_u = 2.0039$, $g_v = 2.0031$, and $g_w = 2.0022$. Hyperfine coupling to the β proton is nearly isotropic with $A^\beta = 44.0$ G. The α-proton hyperfine tensor has principal values, in gauss, of $A_x^\alpha = 7.8$, $A_y^\alpha = 26.9$, $A_z^\alpha = 17.5$. Comparisons between the principal axes for the ESR parameters and the known crystal structure of dihydrothymine indicate that radical formation is accompanied by a conformational change in the pyrimidine ring. This change results in a radical structure that is more nearly planar than the original puckered dihydrothymine molecule. Irradiation and observation at 77°K revealed that both the 5-thymyl radical and the 6-thymyl radical are formed, but the relative quantities of the two radicals are different than at room temperature. (auth)

27160 FREE-ION YIELDS IN SUNDRY IRRADIATED LIQUIDS. Schmidt, Werner F.; Allen, A. O. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys.; 52: 2345-51(1 Mar 1970).

The yield of free ion pairs formed by 2-MeV x rays was determined in 38 pure liquids and in four mixed systems at room temperature, and in five liquids as a function of temperature. Marked effects of molecular constitution are found to be superimposed over the effects of dielectric constant and density of the liquids. (auth)

27161 ESR STUDY OF AN IRRADIATED CRYSTAL OF L-ALANINE: TWO NEW PROTON–DEUTERON EXCHANGE REACTIONS. Itoh, Koichi (Osaka Univ.); Miyagawa, Ichiro; Chen, C. S. J. Chem. Phys.; 52: 1822-7(15 Feb 1970).

Two new proton–deuteron exchange reactions in an irradiated crystal of alanine were discovered with the use of α-deutero-L-alanine. It was shown that both exchanges took place between the radical and its adjacent molecule (or molecules): Exchange I took place between the α hydrogen of the radical and a methyl hydrogen of the molecule, and exchange II between a methyl hydrogen of the radical and the α hydrogen of the molecule. Both exchange rates were much higher than the rate of the previously reported one for irradiated alanine (exchange III). Activation energies for exchange I and exchange II were found to be 17.0 ± 1.0 kcal/mole and 21.0 ± 1.5 kcal/mole, respectively. (auth)

27162 THERMAL AND RADIOLYTIC DECOMPOSITION OF $K_3Mn(C_2O_4)_3.3H_2O$. Bancroft, G. M.; Dharmawardena, K. G.; Maddock, A. G. (Cambridge Univ., Eng.). Inorg. Nucl. Chem. Lett.; 6: 403-8(Apr 1970).

During the thermal decomposition of $K_3Mn(C_2O_4)_3 \cdot 3H_2O$, which begins at about 80°C, the dark red Mn(III) complex is reduced to a white Mn(II) compound to which was assigned the formula $K_2(C_2O_4)_2$ Mn(II)OXMn(II)$(C_2O_4)_2$ (where OX = quadridentate oxalate group). In the presence of air further thermal reaction occurs at 250° to give K_2CO_3 and Mn_3O_4; at 700° a mixture of potassium manganate and carbonate is obtained. Gamma radiolysis of $K_3Mn(C_2O_4)_3 \cdot 3H_2O$ produced a white compound consistent with the formula $K_2Mn(C_2O_4)_2(H_2O)_2 + \frac{1}{2} K_2C_2O_4$. (J.G.B.)

27163 RADIOLYSIS OF 1-HEXADECANE- AND 1-OCTADECANETHIOLS. Chirakadze, G. G.; Nanobashvili, E. M.; Mosashvili, G. A. (Inst. of Inorganic and Electro-Chemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 57: 341-4(Feb 1970). (In Russian).

The radiation-chemical transformation of 1-hexadecanethiol and 1-octadecanethiol, under different physicochemical conditions was investigated. The influence of molecular weight of the aliphatic mercaptans (C_3-C_{18}) on their radiation-chemical transformation and on the nature of the formed products of radiolysis was established. (auth)

27164 NETWORK FORMATION INDUCED BY ACETYLENIC COMPOUNDS IN THE POLYMERIZATION OF METHYL METHACRYLATE. Hagiwara, Miyuki; Yamaji, Katsuhiro; Mitsui, Hiroahi; Kagiya, Tsutomu (Takasaki Radiation Chemistry Research Establishment, Gunma, Japan). J. Polym. Sci., Part B; 8: 155-8(Mar 1970).

The crosslinking effect of acetylenic compounds in the polymerization of methyl methacrylate with a radical initiation, uv light, or γ irradiation was investigated. In γ-induced polymerization, gel formation was not observed without acetylene but a gel fraction of 100% was observed in the presence of acetylene. The effects of several other compounds with a triple bond were also investigated. (M.C.G.)

27165 IRRADIATED OLEFIN OXIDE POLYMERS. Spooncer, William W.; Bauer, Ronald S. (to Shell Oil Co.). U. S. Patent 3,501,389. 17 Mar 1970. Filed 29 Mar 1963.

A process for production of linear thermoplastic polymers of olefin epoxides comprises exposing the epoxide monomer in the condensed phase, usually in the absence of O, to high-energy ionizing radiation. The polymers have molecular weights over twice as high as those produced by conventional methods. Of the olefin oxide monomers polymerizable by this method, the preferred monomer is isobutylene oxide. The radiation may be electrons, photons, or protons with substantial penetrating power. (B.L.M.)

27166 EFFECTS OF IONIZING RADIATION UPON α-TOCOPHEROL ACETATE. Uralova, Minna; Abel, Emil (Vyskumny Ustav Hygieny, Bratislava). Prum. Potravin; 19: 581-2 (Nov 1968). (In Czech).

It was ascertained that α-tocopherol acetate is very sensitive to ionizing irradiation. The higher the radiation dose the more intensive is the decomposition, which also depends on concentration. The lower the concentration the more pronounced is the decomposition. The stability of vitamins under irradiation is an extremely important problem in food industries using pasteurization and sterilization. (auth)

27167 KINETIC AND SPECTRAL STUDIES OF A PRIMARY SPECIES IN PULSE RADIOLYSIS. Shubin, V. N.; Kabakchi, S. A.; Beruchashvilli, L. P.; Dolni, P. I. (Academy of Sciences, Moscow). Int. J. Radiat. Phys. Chem.; 2: 1-20(Apr 1970). (In Russian).

The kinetics of interaction between acceptors and the primary reducing particles formed by radiolysis of aqueous alkaline solutions were investigated. The decay kinetics of the primary species with λ_{max} = 720 nm was studied in aqueous solutions, saturated with hydrogen or helium, containing 10^{-2} to 10 mole/l KOH, $1.4.10^{-5}$ to $1.4.10^{-4}$ mole/l oxygen and 5.10^{-5} to 1.10^{-4} mole/l sodium nitrate, and subjected to pulse radiolysis using a 5-MeV linear electron accelerator with 2.5-μs pulses, the dose per pulse being varied from 150 to 3000 Rad. The approach presented is of general character and its conclusions can be used regardless of the nature of the primary particle (polaron or exciton). The analysis of the effects of temperature on the maximum of the optical absorption of the primary species formed in the pulse radiolysis of crystalline ice suggests that the decisive role in its formation should be attributed to electron-dipole interaction and not to pure electronic interaction. A model for the reducing species is discussed based on the possible stabilization of a primary excited water molecule or of an exciton in the form of a quasi-complex, a metastable F-center or an ion-pair. (UK)

27168 TRAJECTORY STUDY OF ^{32}P RECOIL IN SODIUM PHOSPHATES. Bunker, Don L.; Van Volkenburgh, Gregg (Univ. of California, Irvine). J. Phys. Chem.; 74: 2193-6 (14 May 1970).

A classical trajectory study was made of the recoil of ^{32}P from $^{31}P(n,\gamma)^{32}P$, in several kinds of sodium phosphate crystals. The chemical effects of this were extensively studied, but the results were inconclusive. The calculations strongly suggest that in anhydrous crystals, the primary process is the ejection of either P or P + O (or P + OH, in sodium hydrogen phosphates) from the crystal cage. These fragments traverse only a few neighboring sites before becoming bound. When there is water of hydration, escape of P is severely impeded. It either remains in its original cage or comes to rest in an adjoining one. Preservation of a P–O bond during the recoil process is extremely unlikely. (auth)

27169 CARBONATE RADICAL IN FLASH PHOTOLYSIS AND PULSE RADIOLYSIS OF AQUEOUS CARBONATE SOLUTIONS. Behar, David; Czapski, Gideon; Duchovny, Itzhak (Hebrew Univ., Jerusalem). J. Phys. Chem.; 74: 2206-10(14 May 1970).

The carbonate radical, CO_3^-, may be generated by the reaction of carbonate or bicarbonate ions with hydroxyl radicals. The flash photolysis of hydrogen peroxide solutions and the pulse radiolysis of water were utilized as sources of hydroxyl radicals from which it was found that the basic form of the hydroxyl radical, O^-, contributes little to the production of CO_3^-, even up to pH 14. Reactions of CO_3^- with hydrogen peroxide ($k = 8 \times 10^5$ M^{-1} sec^{-1}) and with HO_2^- ($k = 5.6 \times 10^7$ M^{-1} sec^{-1}) were observed. The carbonate radical and the perhydroxyl radical ion, O_2^-, were formed in equimolar concentrations in the flash photolysis of oxygen-saturated carbonate solutions, and from this, the extinction coefficient of O_2^- was found to be 1850 ± 200 M^{-1} cm^{-1} by comparison with the better known extinction coefficient of CO_3^-. The product of the reaction $CO_3^- + O_2^-$ was assumed to be CO_5^{2-} having a half-life time of several seconds and $\epsilon^{260}_{CO_5^{2-}}$ = 410 M^{-1} cm^{-1}. (auth)

27170 FREE RADICAL CHAIN REACTIONS IN THE RADIOLYSIS AND PHOTOLYSIS OF ISOBUTYL BROMIDE. Bakale, Donna Kutsko; Gillis, Hugh A. (Case Western Reserve Univ., Cleveland. National Research Council, Ottawa). J. Phys. Chem.; 74: 2074-82(14 May 1970).

The radiolysis or photolysis of isobutyl bromide results in isomerization to t-butyl bromide and decomposition to isobutylene and hydrogen bromide with initial yields that are characteristic of chain processes. These decomposition products reach equal plateau concentrations of about 0.05 mole % at low doses for pure isobutyl bromide. The effects of dose rate and of adding isobutylene, hydrogen bromide, or ethylene on the major products were studied. All of the observations are consistent with a free radical chain mechanism in which the following are important reactions: $Br\cdot + (CH_3)_2CHCH_2Br \rightleftharpoons HBr + (CH_3)_2\dot{C}CH_2Br$ (5), $Br\cdot + (CH_3)_2=CH_2 \rightleftharpoons (CH_3)_2\dot{C}CH_2Br$ (6), $Br\cdot + (CH_3)_2C=CH_2 \rightleftharpoons (CH_3)_2CBrCH_2\cdot$ (7). From the data equilibrium constants are calculated for these reactions: $K_5 = (7.9 \pm 2.2) \times 10^{-4}$; $K_6 = 323 \pm 60$ l mol^{-1}; $K_7 = 4 \pm 2$ l mol^{-1}. The activation energy for reaction 6 is estimated at 8.5 kcal mol^{-1}. The production of t-butyl bromide could also be explained by an intraradical bromine atom shift or by the formation of a bridged bromoalkyl radical, instead of by reaction 7. (auth)

27171 RADICALS FORMED BY THE REACTION OF ELECTRONS WITH AMINO ACIDS IN AN ALKALINE GLASS. Sevilla, Michael D. (Atomics International, Canoga Park, Calif.). J. Phys. Chem.; 74: 2096-2102(14 May 1970).

The reactions of electrons with a number of amino acids in an alkaline D_2O glass were investigated by use of electron spin resonance spectroscopy. The electron initiates a series of reactions on attachment to glycine and alkyl-substituted amino acids. Electron attachment at 77°K first produces the dianion, which deaminates on warming to produce a second radical species. Further warming to the softening point of the glass results in the appearance of a third radical species. The ESR spectra of this species are consistent with the structure, $ND_2-\dot{C}(R)-CO_2^-$, which indicates that the deaminated species is abstracting from the α carbon of the parent amino acid. Reactions of electrons with other amino acids depend on the nature of the side group. For example, electron attachment to methionine produces methyl radicals by cleavage of the $S-CH_3$ bond, and electron attachment to asparagine produces an anion of the amide group. The radical intermediates identified were found to be in agreement with those proposed from investigations of the radiolysis of aqueous solutions of amino acids. A comparison of results of this work with those found in ESR investigations of irradiated single crystals shows that the subsequent reactions of the deaminated radical species of amino acids with alkyl side groups are different in aqueous media than in crystalline amino acids. (auth)

27172 PULSE RADIOLYSIS STUDIES OF DEAERATED ALCOHOLIC SOLUTIONS OF ALKALI HALIDES AND POTASSIUM HYDROXIDE. Arai, Shigeyoshi; Kira, Akira; Imamura, Masashi (Inst. of Physical and Chemical Research, Saitama, Japan). J. Phys. Chem.; 74: 2102-7(14 May 1970).

The pulse radiolysis of alcoholic solutions of alkali halides and potassium hydroxide was studied in the concentration range from 10^{-2} to 3M. Absorption bands due to Cl_2^-, Br_2^-, and I_2^- were observed in irradiated solutions of alkali halides. On the other hand, the light-absorbing species in irradiated solutions of potassium hydroxide may be assigned to the CH_2O^- radical and the CH_3CHO^- radical. Further, the intense absorption due to the solvated electron was observed in all cases. Yields of the solvated electron increase with increase in concentration of the solutes. This may be attributed to the reaction $ROH^+ + X^- \rightarrow ROH + X$ leading to a decrease of the charge neutralization between the solvated electron and the positive ion in the spur region. A halogen atom produced by this reaction combines with a halogen ion. (auth)

27173 CHEMILUMINESCENT REACTIONS AFTER PULSE RADIOLYSIS OF AQUEOUS SOLUTIONS OF ACRIFLAVIN. EFFECTS OF HALIDES AND PSEUDO HALIDES. Pruetz, W. A. (Univ., Freiburg i. B.); Land, E. J. J. Phys. Chem.; 74: 2107-14(14 May 1970).

Chemiluminescent emissions occurring after pulse radiolysis of aqueous solutions of acriflavin can be enhanced up to three times in the presence of X^- (halides or pseudo halides). Reactions of e^-_{aq} with the products of X atom or X_2^- attack on the dye are believed to be the cause of the enhanced emissions. (auth)

27174 RADIATION-INDUCED COLOR CENTERS IN GLASSES. Sakka, Sumio (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ.; 48: 53-65(Jan 1970).

The present state of studies on color centers in glasses is reviewed. The current works on color centers are shown to be directed to classification of the color centers (trapped hole or trapped electron), use of color center phenomena as a tool for elucidating the glass structure, and investigation of inorganic

radicals in glass as a solution medium. Investigation of high pressure effect on color centers is presented as an example of their applications to the problem of glass structure. 45 references. (auth)

27175 ESR AND ENDOR INVESTIGATIONS OF RADIATION-INDUCED METASTABLE PARAMAGNETIC CENTERS IN $CaWO_4$. Kikuchi, Chihiro (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ.; 48: 10-39(Jan 1970).

A review of a variety of paramagnetic centers in pure and doped $CaWO_4$, produced by gamma and neutron radiations, is given. Gamma irradiation of samples containing Group V (V, Nb, Ta) elements produces ESR centers with $g > g_e$. It is suggested that these are hole centers. For the Group VI elements Cr and Mo, the g-values are less than g_e, suggesting that these are electron trapping centers. For W (Group VI), there are hole as well as electron trapping centers. The latter are particularly sensitive to the trivalent charge compensating ion. It is shown that two W centers and the Nb-center are responsible for the 155°, 225°, and 290°K thermoluminescent peaks in nominally pure $CaWO_4$ following gamma irradiation. Fast neutron irradiation results in three ESR centers, whose g-values along the c-axis are $g_\alpha = 2.005$, $g_\beta = 1.801$, and $g_\gamma = 1.746$. The γ-center is identified as a paramagnetic W associated with a nearest neighbor oxygen vacancy. Its concentration is in good agreement with Kinchin–Pease theory. The angular dependence of the β-center indicates that it is associated with a defect along the ⟨110⟩ directions. The identity of the α-center is not known. (auth)

27176 RADIATION-INDUCED POLYMERIZATION OF VINYL ACETATE. Sakurada, Ichiro; Ikada, Yoshito; Nishizaki, Yasuko (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ.; 48: 1-9 (Jan 1970).

The γ-radioinduced polymerization of pure vinyl acetate was studied in liquid-phase over the temperature range +62°C to −78°C. The activation energy for overall polymerization was found to be 3.69 kcal/mole. The formation of branching from acetate groups was negligible in the conversion range below about 20%, and considerably high degrees of polymerization (about ten thousands) were obtained in the polymerization at about 0°C. The degree of polymerization–temperature curve was found to exhibit a maximum. This maximum was attributed to a very low activation energy for initiation at the radiation polymerization. The 1,2-glycol content in the hydrolyzed polyvinyl alcohol decreased with decreasing temperature of polymerization and the 1,2-glycol content–temperature curve was in accordance with those found for catalytic polymerizations. From the kinetic analysis of polymerization, the G_R-value of vinyl acetate was found to be between 1 and 2. (auth)

27177 EFFECT OF RADIATION ON COMMON ANALYTICAL REAGENTS. Zittel, H. E. (Oak Ridge National Lab., Tenn.). Progr. Nucl. Energy, Ser. IX; 10: 393-412(1970).

A short review is presented on the basic theory of how radiation affects organic and inorganic analytical reagents, and a summary is given of the specific effects of the different types of radiation on various classes of analytical methods where such effects were studied. Headings are as follows: radiation chemistry (basic theory; radiation measurement units and dosimetry); radiation effects on analytical reagents (effects on solvents-water, organic solvents; effects on acids; redox agents; indicators; complexing agents; use of protective agents). 30 references. (UK)

Radiochemistry

Refer also to abstracts 27470 and 27626.

27178 PREPARATION OF HOT AEROSOL PARTICLE OF ^{60}Co FOR EXPERIMENTAL STUDIES. Bykhovskii, A. V.; Rezvushkin, V. V. Gig. Sanit.; No. 3, 70-4(Mar 1970). (In Russian).

Methods for preparation of radioactive suspensions of ^{60}Co from dusts in instruments using cobalt and from Co_3O_4 are described. Suspensions with particles of 1 to 5 μ in size with specific activities of 1.32 μCi/ml with particle concentrations of 0.98 mg/ml from dry precipitates of 1.35×10^{-3} Ci/g specific activity were obtained and analyzed. It was shown that it was possible to obtain particles containing ^{60}Co with assigned specific activity and size. (R.V.J.)

27179 EPR STUDIES OF 1-NAPHTHYL AND 2-NAPHTHYL RADICALS PRODUCED BY TRITIUM DECAY. Lloyd, R. V.; Wood, D. E. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 52: 2153-4(15 Feb 1970).

Aromatic sigma radicals, specifically the 1-naphthyl and 2-naphthyl radicals, were formed by the decay of tritium in tritiated naphthalene. EPR spectra of the radicals are given. (M.C.G.)

Separation Processes

Refer also to abstracts 26917, 26922, 26968, 26995, and 27059.

27180 (ANL-7612) LABORATORY INVESTIGATIONS IN SUPPORT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART XXI. FILTRATION OF AEROSOLS FROM PLUTONIUM HEXAFLUORIDE HYDROLYSIS. Kessie, Robert W.; Marek, Lawrence J.; Steindler, Martin J. (Argonne National Lab., Ill.). Nov 1969. Contract W-31-109-eng-38. 52p. Dep. CFSTI.

The volatility of PuF_6, combined with the high toxicity of plutonium, requires that a high degree of cleanup be provided for the off-gas from an enclosure in the event of an accidental release of PuF_6 in the enclosure. The concluding phase of a small-scale experimental program on the removal of PuF_6 from ventilation air by hydrolysis to a solid aerosol followed by high-efficiency filtration with fiber filters is described. Five significant variables in relation to plutonium penetration of filters were identified in the study. The variables and their ranges are: the partial pressures of the three reactant gases in the air mixture before reaction, PuF_6 (2×10^{-4} to 2 torr), H_2O (0.3 to 5 torr), and fluorine (9×10^{-7} to 35 torr); the reaction time between (1) mixing of PuF_6, water vapor, and fluorine in air and (2) filtration (2 to 225 sec); and the gas velocity incident on the surface of the filter medium (0.25 to 2.5 cm/sec). The penetration of plutonium through the first high-efficiency filter ranged from 2×10^{-10} to 0.2. Plutonium penetrations smaller than 5×10^{-14} were measured for three filters in series. Empirical correlations, based on the above variables, are reported that give the plutonium penetration of the first filter to within an average error factor of 7 and of the first two filters combined to within an average error factor of 4. The experimental reproducibility appears to be much better than that indicated by the correlation error. Loading effects on pressure drop were measured, and an empirical correlation is presented. Electrostatic effects that increase filter penetration were superficially evaluated, both theoretically and experimentally. (auth)

27181 (ANL-7615, pp 18-25) SEPARATION OF CESIUM AND RUBIDIUM BY THE FERROCYANIDES OF COPPER, ZINC, AND ZIRCONIUM. Edgington, D. N.; Thommes, M. M.; Harrison, L. I. (Argonne National Lab., Ill.).

The suitability of several metal ferrocyanides for ion exchange separation of cesium and rubidium has been studied. Both cesium and rubidium were satisfactorily absorbed on zinc ferrocyanides and could be recovered in separate fractions by elution with solutions of nitrate ion. Zirconium ferrocyanide absorbs cesium strongly and is well suited to concentrate cesium when subsequent elution is not required, e.g., to separate fallout ^{137}Cs from seawater. Copper ferrocyanide absorbs both cesium and rubidium strongly, but is of little value in analysis because of difficulties in elution of adsorbed species. (auth)

27182 (ARH-1343) PLUTONIUM–URANIUM PROCESSING IN THE PLUTONIUM RECLAMATION FACILITY BY COEXTRACTION–PARTITION. Bruns, L. E. (Atlantic Richfield Hanford Co., Richland, Wash.). 25 Sept. 1969. 48p. Dep. CFSTI.

By plant testing and subsequent laboratory investigations, a flowsheet was developed that will allow processing of plutonium–uranium scrap in the Plutonium Reclamation Facility (PRF). By eliminating or minimizing the nitrite in the extraction feed, adding a side stream of hydroxylamine nitrate in the partition column, assuring organic transfer between packed columns via special pumps, and adding a small organic acidification–purification column, plutonium–uranium rates of 10 kg/day (2 to 5 kg uranium/day) can be processed within six months in the PRF. With a subsequent extension of the stripping column and an extension of the CR column, plus air pulsing the CR column, rates of 20 kg uranium + plutonium/day can be achieved. Adding a plutonium product scrub column should give the desired 30 kg uranium + plutonium/day. (auth)

27183 (ARH-1639) B PLANT RECOVERY OF CESIUM FROM PUREX SUPERNATANT. Brandt, H. L. (Atlantic Richfield Hanford Co., Richland, Wash.). 23 Mar 1970. Contract AT(45-1)-2130. 7p. Dep. CFSTI.

A flowsheet for removal of cesium by ion exchange from Purex stored alkaline waste (PSN) is presented. The cesium, after removal by the zeolite, is eluted as aqueous ammonium carbonate. The carbonate is concentrated, transformed to cesium nitrate, and stored. (M.C.G.)

27184 (BNL-50228) EVALUATION OF IAEA SAFEGUARDS INSPECTION AT NUCLEAR FUEL SERVICES, WEST VALLEY, N. Y. Suda, Sylvester C. (Brookhaven National Lab., Upton, N. Y.). 30 Mar 1970. 39p. Dep. CFSTI.

Operational activities began on May 2, 1969, with the inventory

of the Yankee fuel assemblies in the NFS fuel storage basin and continued through July 22 when the last plutonium bottle was stored in the ASDA PSF. The safeguarded fuel consisted of 74 spent Yankee fuel assemblies each containing about 264 and 2.38 kilograms of uranium and plutonium respectively. The burnup range for the 72 stainless steel clad fuel assemblies was 12,120 to 27,260 megawatt days per metric ton uranium (MWd/MTU). Two Zircaloy-clad fuel assemblies had burnup of about 10,000 MWd/MTU. A plot of the cumulative material flow through mechanical processing, input measurements, and plutonium loadout is presented. The amount of plutonium holdup in the mechanical process area and the solvent extraction system at any point in time can be approximated using the right hand scale (kg Pu). The safeguarded material consisted of 176.0 kilograms of plutonium. A trial material balance for the campaign is given. Results and problems are discussed. (M.C.G.)

27185 (BNWL-1384) CAPABILITY OF A TYPICAL MATERIAL BALANCE ACCOUNTING SYSTEM FOR A CHEMICAL PROCESSING PLANT. Schneider, R. A.; Granquist, D. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. Contract AT(45-1)-1830. 35p. Dep. CFSTI.

The development of two basic models, a capability model and a performance model, for a chemical processing facility is discussed. The capability model represents the best performance (the smallest error) that the measurement system is theoretically capable of achieving in an operating environment. The performance model represents what might more generally be expected in practice from a high quality measurement system. A Purex-type flowsheet was assumed for a plant operating on a clean-plant-to-clean-plant basis. It was also assumed that a campaign consists of 40 tons of irradiated low-enriched uranium containing 10,000 g/ton of plutonium. (M.C.G.)

27186 (BNWL-tr-48) SOLIDIFICATION OF HIGH-LEVEL RADIOACTIVE WASTES. PART 1. SELECTION OF THE RAW MATERIALS. Saidl, J.; Ralkova, J. Translated by Elaine Foskett (Battelle-Northwest, Richland, Wash.), from Kernenergie; 10: 92-5(1967). 10p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 25939.

27187 (BNWL-tr-50) SOLIDIFICATION OF HIGH-LEVEL WASTES. PART 4. ION DIFFUSION IN BASALT IN A RADIATION FIELD. Ralkova, J.; Saidl, J. Translated by Elaine Foskett (Battelle-Northwest, Richland, Wash.), from Kernenergie; 10: 340-3(1967). 8p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 16660.

27188 (IN-1364) UNDISSOLVED URANIUM ALUMINIDE IN REPROCESSING OF TEST REACTOR FUELS. Paige, B. E.; Jacobson, M. E.; Evans, T. L.; Barnes, V. H. (Idaho Nuclear Corp., Idaho Falls). Mar 1970. Contract AT(10-1)-1230. 47p. Dep. CFSTI.

During the dissolution of newer uranium–aluminum alloy fuels, uranium dissolved more slowly than aluminum. Study showed that the elutriation of uranium aluminide particles from a continuous dissolver can be experienced. The effects of irradiation, the fuel fabrication method (wrought alloys vs powder metallurgy), and dissolver operating conditions upon this phenomenon were determined. The dissolution rates and the shapes and sizes of such particles were compared. Recommendations for procedures to ensure complete dissolution of uranium during chemical reprocessing of uranium–aluminum fuels are made. (auth)

27189 (MLM-1612) MOUND LABORATORY CHEMISTRY AND PHYSICS PROGRESS REPORT, OCTOBER-DECEMBER 1969. (Mound Lab., Miamisburg, Ohio). 11 May 1970. Contract AT-33-1-GEN-53. 23p. Dep. CFSTI.

Topics covered include: preparation of LiH and LiD single crystals, residue adsorption, ^{234}U recovery, ^{210}Po recovery, boron recovery, comparison of γ scan and calorimetry data on cans of ^{238}Pu residues, determination of U concentration by isotope dilution method, isotopic analysis of enriched boron samples, plutonium isotopic sample exchange data evaluation, improving scan speed and attenuation reliability of a mass spectrometer, and temperature-integrator data collection system. (M.C.G.)

27190 (ORNL-tr-2303) DEVELOPMENT WORK ON REPROCESSING OF THORIUM NUCLEAR FUELS. (Nuklear-Chemie und-Metallurgie G.m.b.H., Wolfgang bei Hanau (West Germany)). Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Designation WA 101/68, Report 6. 11p. Dep. CFSTI.

The development of a head-end combustion process is described. In the second half of 1969 the hot-cell experiments begun in Juelich with a small laboratory furnace were continued. In Wolfgang the combustion was tested on an industrial scale with air enriched in oxygen. On the basis of the present state of knowledge, improved industrial design for a plant of 10 kg fissionable material per day was developed. Fundamentally different results are obtained for carbide and oxide elements in regard to the release of liquid and gaseous fission products. The retaining power of the mixed oxide crystals for ^{85}Kr amounted to about 98%, while in the case of the lattice transformation of the carbide to the finely divided oxide, more than 98% of the noble gas was released. In the case of the carbide fuel, only 60 ppM of the heavy metal that decomposes into dust, including the incorporated fission product, were discharged through the metal filter candles of the furnace into the deep bed filter. The latter had a good separating capacity for the dust, but that for the gaseous and aerosol nuclides such as ^{137}Cs and ^{103}Ru was insufficient. The procedure of purification of the off-gas is much simpler in the case of oxide fuel. The ash, consisting of largely intact cores of particles, leads to the supposition that with the exception of ^{85}Kr all other volatile and solid fission products were for the most part retained in the furnace. The furnace has operated in experiments totaling 220 hours without trouble. In this time 120 active fuel elements and 78 inactive graphite spheres were burned. The residual carbon content of the ash was in some cases less than 1%. (auth)

27191 (UCRL-19525) FOAM FRACTIONATION OF RARE-EARTH ELEMENTS. Robertson, George H.; Vermeulen, Theodore (California Univ., Berkeley. Lawrence Radiation Lab.). Dec 1969. Contract W-7405-eng-48. 138p. Dep. CFSTI.

Thesis. Submitted by George H. Robertson.

The foam fractionation of rare earth elements Nd, Sm, and Ce by extraction of their EDTA chelates with a cationic surfactant, and the foam fractionation of an anionic surfactant were studied. The objective was to determine the usefulness of the foaming technique in fine separations and to examine quantitatively the properties of transient foaming in producing the separation. The model of "persistent" foaming did not apply to most of the foaming conditions, which were found to favor foam formation, extraction, and fractionation. Therefore, a two-property classification was adopted; the type being determined by the persistence or transience of surface area, and the mode by the constancy or depletion of specific liquid content with foam height or age. In a preliminary study, fixed-height foaming from aqueous solutions of an anionic surfactant (Aerosol 22) was used to evaluate the effect of gas rate on the relative transiency and separation performance. Foaming of Aerosol-22 in a transient regime of gas rates yielded the best enrichments and extraction. The foam liquid fraction was proportional to the 0.20 power of the gas velocity in the transient regime and to the 0.71 power in the persistent regime. For rare earth separation, separate cationic surfactant (Hyamine 1622) and chelating agent (EDTA) were employed to obtain good foaming and extraction as well as selectivity. Transient foaming for rare earth separations was observed for all concentrations of surfactant tested; transiency increased as the surfactant concentration decreased. Separation factor (1.9 for Nd/Ce and 3.1 for Sm/Ce) was invariant above 17cm and decreased sharply to 1.0 below 17cm. Extraction, constant above 17cm, was best in the most transient foams. Appreciable separation improvement was achieved by blocking foam with stacks of screens or plastic bead packings. These devices also increased the foam liquid content. (auth)

27192 CURRENT DENSITY EFFECT ON LITHIUM ISOTOPE SEPARATION BY ELECTROMIGRATION IN A CATION EXCHANGE MEMBRANE. Okamoto, M.; Fujii, Y.; Aida, M.; Kakihana, H. (Tokyo Inst. of Tech.). Isotopenpraxis; 6: 69-73(Feb 1970).

The effect of current density on the isotope effect in the method of electromigration for separation of ^6Li from ^7Li was studied. The single process enrichment factor was not dependent either on the type of migration technique or on the migration length, but confirmed that the current density influences the isotope effect. (M.C.G.)

27193 RADIOCHEMICAL PURIFICATION OF NATURAL TELLURIUM IRRADIATED IN A REACTOR. Bulbulian, S. (Comision Nacional de Energia Nuclear, Mexico City). Kerntechnik; 12: 123-4(Mar 1970).

A method to remove long-lived radioactive impurities from natural tellurium irradiated by thermal neutrons is described; impurities were adsorbed by activated charcoal with an overall efficiency of 99.98%. (auth)

27194 PROCESS FOR THE DRY DIRECT CONVERSION OF URANIUM HEXAFLUORIDE INTO SINTERABLE URANIUM DIOXIDE. Pirk, H.; Tillessen, U. (Nukem, Nuklear-Chemie und -Metallurgie GmbH, Wolfgang, Ger.). Kerntechnik; 12: 117-22(Mar 1970). (In German and English).

The investigated conversion process is based on the gas reaction

of UF_6 with NH_3 producing solid UF_4 above 400°C, followed by pyrohydrolysis of UF_4 to sinterable UO_2. A continuously operating industrial scale fluidized bed reactor is described, serving for the direct conversion of UF_6 into UO_2 granulate. The quality of the product in respect to further processing into shaped sintered pellets is discussed and is compared with that of UO_2 powder produced by a standard wet chemical process. In conclusion, the overall flowsheet of a semi-continuous process is discussed, entailing 4 steps: conversion of UF_6 to UO_2, second pyrohydrolysis, homogenisation, and conditioning. (auth)

27195 EXTRACTION OF FISSION PRODUCTS AND OF TRANSURANIDE ELEMENTS FROM RADIOACTIVE WASTES. Ramdohr, H. (Friedrich Uhde GmbH, Dortmund, Ger.). Kerntechnik; 12: 128-30(Mar 1970). (In German and English).

Extraction of fission products on a large scale is not economical at present because of the paucity of applications resulting in a small market. This does not affect the fact that fuel reprocessing wastes still remain the source for the extraction and purification of many nuclides, but the quantities disposable on the market are small. The extraction of long-lived nuclides does not simplify or reduce the cost of wastes management. On the other hand, however, the extraction of neptunium and of some higher transuranide elements does appear to be promising. (auth)

27196 VOLATILIZATION OF UF_6 IN A FIXED BED AND IN A FLUIDIZED BED IN THE CONTEXT OF DRY REPROCESSING OF NUCLEAR FUELS CONTAINING THORIUM. Friedrich, H.; Kreutz, R.; Massonne, J. (Kali-Chemie AG, Hanover). Kerntechnik; 12: 105-9(Mar 1970). (In German and English).

The uranium fraction of unirradiated spherical oxidic and carbidic U/Th particles can be volatilized as uranium hexafluoride, after burning off the carbon coating, by treating the particles consecutively, in a fixed or in a fluidized bed, with hydrogen fluoride at 400 to 450°C and then with elementary fluorine at 600 to 700°C. The residual uranium content amounts to 0.05% in the case of carbide particles and to 0.13% in the case of oxidic particles. A somewhat less complete volatilization of uranium from the U/Th oxides obtained after burning off the carbon can also be achieved by direct fluorination with elementary fluorine. By subjecting the fluorides obtained by either of these two methods to a pyrohydrolysis followed by a second treatment with hydrogen fluoride and with elementary fluorine, the residual uranium content can be reduced to a few 10^{-2}%. (auth)

27197 VOLATILIZATION OF UF_6 BY FLUORINATION OF FLUORIDE MELTS IN THE CONTEXT OF DRY REPROCESSING OF NUCLEAR FUELS CONTAINING THORIUM. Kreutz, R.; Massonne, J.; Friedrich, H. (Kali-Chemie AG, Hanover). Kerntechnik; 12: 109-11(Mar 1970). (In German and English).

Spherical oxidic U/Th particles are converted into U/Th fluorides by treatment with hydrogen fluoride at 400 to 500°C, and the fluorides are then melted down with addition of other appropriate metal fluorides, e.g., LiF + NaF. The uranium is then volatilized as uranium hexafluoride by treatment with elementary fluorine at 550 to 600°C down to a residual content of less than 2.4×10^{-2}%. (auth)

27198 DESIGN OF A SEPARATION COLUMN FOR THE COUNTERCURRENT ELECTROLYTIC SEPARATION METHOD. X. REPORT ON COUNTERCURRENT ELECTROLYSIS. Behne, D. (Hahn-Meitner-Institut, Berlin). Kerntechnik; 12: 112-16 (Mar 1970). (In German and English).

The design, function, and efficiency of a separation column for the countercurrent electrolytic method are described. By virtue of its simple construction, the dimensions and shape of the column can be adapted to suit a wide range of diverse separation problems. The properties of the column were tested in the separation of potassium and rubidium isotopes. (auth)

27199 CONCENTRATION AND SEPARATION OF URANIUM WITH ION-EXCHANGE RESINS. Jercan, Elena; Dinoiu, Luminita (Univ., Bucharest). Anal. Chim. Acta; 50: 166-9(Apr 1970). (In French).

A method is described for the separation of U from Cu(II), Pb(II), Cd(II), Co(II), Ni(II), Mn(II), Zn(II), and especially Fe(II) in minerals by ion exchange. The method is based on the affinity of U for the glycine ligand. The separation from Fe(II) presented more of a problem than the other elements because it formed an insoluble complex with glycine. In order to avoid this, 2,2'-bipyridine, which forms a soluble complex with iron, was introduced into the system. (P.C.H.)

27200 A PROCESS FOR RECOVERING URANIUM AS URANIUM DIOXIDE. (to Japan Atomic Energy Research Inst.). British Patent 1,188,063. 15 Apr 1970. Priority date 3 Feb 1967, Japan.

Uranium was recovered from HNO_3 solutions containing U by extraction using a solution of TBP in an organic solvent, distillation of the organic phase under reduced pressure at a temperature of <210°C, and ignition of the distillation residue under reduced pressure at a temperature of at least 1300°C to produce UO_2. This process is applicable to the recovery of U from reactor fuel elements. (B.L.M.)

27201 PROCESS AND APPARATUS FOR REMOVING PROTIUM AND TRITIUM FROM HEAVY WATER. (to Commissariat a l'Energie Atomique). British Patent 1,189,015. 22 Apr 1970. Priority date 9 Aug 1966, France.

A process for the removal of protium and tritium from heavy water comprises trapping the heavy water contained in a nuclear reactor or pile to form a continuous flow of trapped heavy water, subjecting this trapped fraction to an isotopic exchange reaction with gaseous deuterium to lower the protium and tritium content in the trapped heavy water, removing the protium and tritium from the enriched deuterium by fractional distillation to yield a first part enriched in tritium and a second part enriched in protium. The gaseous deuterium is then recirculated. The apparatus for carrying out the process is described also. (B.L.M.)

27202 SEPARATION OF YTTRIUM FROM IRRADIATED URANIUM SAMPLES BY EXTRACTION CHROMATOGRAPHY. Smulek, Wiktor (Inst. of Nuclear Research, Warsaw); Moszynska, Krystyna. Nukleonika; 14: 1123-30(1969).

A new procedure has been developed for the clean separation of carrier-free yttrium from irradiated uranium samples. The separation was realized by extraction chromatography (reversed-phase partition chromatography) with bis(2-ethylhexyl) orthophosphate as the extractant. Elution was carried out with nitric acid of varying concentration. The separated yttrium contains no γ-active impurities according to gamma spectrometry. The procedure may be used for isolating ^{91}Y from irradiated uranium. (auth)

27203 INVESTIGATION OF THE LEACHING OF URANIUM FROM CRUSHED MAGMATIC ROCK. Szalay, Sandor; Samsoni, Zoltan. Geochem. Int. (Engl. Transl.); 6: 613-23(1969).

Translated from Foldt. Kozl.; 97: No. 1, 60-72(1967).

Conditions of uranium leaching from crushed granite, andesite, gabbro, and basalt samples from various localities were investigated by laboratory experiments. The extent of uranium leaching from granite detritus was found to be greater than any of the other type of rocks. For all types of rocks investigated, the uranium content of the leaching water reached an equilibrium concentration within a few hours. This was found to be the result of two opposing processes, leaching of uranium by the water and surface adsorption on rock particles. By considering the data obtained large variations of uranium in ground waters and the first stage of uranium accumulation in bioliths can be explained. (auth)

27204 CATION-EXCHANGE STUDIES OF CADMIUM ON DOWEX 50 W-X8: SEPARATION FROM MIXTURES. Akki, S. B.; Khopkar, S. M. (Indian Inst. of Tech., Bombay). Z. Anal. Chem.; 249: 228-30(6 Mar 1970).

Cation-exchange behavior of mg amounts of cadmium on Dowex 50W-X8 was studied. Hydrochloric, nitric, perchloric, and sulfuric acids, solutions of ammonium acetate, chloride and bromide, sodium chloride and nitrate, potassium iodide and EDTA were tested as eluants. The relative efficiency of the eluants is discussed in terms of their elution constants and volume distribution coefficient. Cadmium can be separated from a wide variety of elements. The overall operation requires about 3 to 4 hrs. Results are reproducible to ±2.5%. (auth)

27205 NIOBIUM AND TANTALUM IN CARBON DIOXIDE SOLUTIONS. Aleksandrov, I. V.; Trusikova, T. A.; Tupitsin, B. P. (Vernadskii Inst. of Geochemistry and Analytic Chemistry, Moscow). Geochem. Int. (Engl. Transl.); 6: 558-66 (1969).

Translated from Geokhimiya; No. 6, 673-82(Jun 1969).

Experiments show the niobium concentration is considerably higher than that of tantalum in solutions of potassium carbonate in a wide range of pH, temperature (185 to 555°C), and pressure (500 to 2000 kg/cm^2). This is attributed to the greater stability of carbonate complexes of niobium. One of the main causes for niobium separation from tantalum is therefore the difference between their respective mobilities. (auth)

27206 ISOTOPIC COMPOSITION OF DIFFERENT FORMS OF SULFUR IN WATER AND SEDIMENTS OF SERNOYE LAKE (SERGIEVSK MINERAL WATERS). Pankina, R. G.; Mekhtieva, V. L. (All-Union Inst. of Petroleum Geology, Moscow). Geochem. Int. (Engl. Transl.); 6: 511-16(1969).

Translated from Geokhimiya; No. 5, 589-94(May 1969).

The isotopic composition of various sulfur forms was studied

in water and muds of the Sernoye Lake (Sulfur Lake) as well as in the water of springs feeding the lake and the Molochnyy Creek that flows out of it. $\delta^{34}S$ of hydrogen sulfide and sulfates in the water of the springs, the lake and the creek varies slightly ($\delta^{34}S/H_2S$ from $-22.8‰$ to $-25.2‰$, $\delta^{34}S/SO_4^{2-}$ from $+12.4‰$ to $+14.7‰$). Sulfides from lake sediments are isotopically close to solution sulfide; sulfates are, on the contrary, lighter than water sulfates. Elemental sulfur from lake mud approaches the initial H_2S composition and is approximately $35‰$ enriched in ^{32}S in comparison with water sulfates. (auth)

27207 MOBILITY OF LEAD ISOTOPES IN ROCKS. Danilov, L. T.; Keshishyan, G. O.; Bugrov, N. M. (All-Union Inst. of Applied Geophysics, Leningrad). Geochem. Int. (Engl. Transl.); 6: 504-10(1969).

Translated from Geokhimiya; No. 5, 582-8(May 1969).

Leaching experiments with dilute HCl and/or with a mixture of concentrated HCl and HNO_3 indicate that the mobility (leachability) of lead is a function of acid concentration as well as of the type of material treated. For example, in weathering products of silicic volcanics, 90 to 95% of the lead can be leached with 0.2 N HCl with no change in isotopic composition. In contrast, only 26% of the lead in granites (Precambrian) can be removed with 0.1 N HCl, with enrichment of ^{206}Pb in the leached fraction. (auth)

27208 INVESTIGATION OF CONDITIONS OF OXIDATION OF PRASEODYMIUM (TERBIUM) WITH SUBSEQUENT SEPARATION $Pr(3^+-4^+)$[$Tb(3^+-4^+)$] BY THIN-LAYER CHROMATOGRAPHY. Vagina, N. S. Zh. Prikl. Khim.; 43: 47-50(Jan 1970). (In Russian).

The oxidized form of tetravalent praseodymium was studied by spectrophotometry. The separation of trivalent from tetravalent Pr was conducted by thin-layer chromatography. Similar behavior was found for terbium under identical conditions, but neodymium and erbium did not show this behavior. (tr-auth)

27209 SYNTHESIS AND PHYSICAL PROPERTIES OF A NOVEL AMINOPHOSPHONIC ACID AS AN EXTRACTING AGENT FOR METALS. Jagodic, V.; Herak, M. J. (Inst. Rudjer Boskovic, Zagreb). J. Inorg. Nucl. Chem.; 32: 1323-32(Apr 1970).

The synthesis of the mono-octyl ester of [α-(2-carboxyanilino) benzyl] phosphonic acid (MOCABP) is described and its physical properties are discussed. The ir and uv absorption spectra of MOCABP, as well as its molecular weights in chloroform solution as a function of the reagent concentration, ionization constants, and partition between chloroform and 1M aqueous perchlorate solution were experimentally determined. The extraction of europium, manganese, and strontium with MOCABP is described, and a comparison with the mono-octyl ester of α-anilinobenzylphosphonic acid (MOABP) is made for the same metals. (auth) (UK)

27210 RESOLUTION CONCEPT FOR SEPARATION OF CURIUM FROM CALIFORNIUM BY ION-EXCHANGE CHROMATOGRAPHY. Aly, H. F.; Latimer, R. M.; Abdel-Rassoul, A. A. (Atomic Energy Establishment, Cairo). Talanta; 17: 265-72 (Apr 1970).

Different factors affecting separation of the tervalent actinides curium and californium by ion-exchange chromatography are discussed in the light of the resolution factor. The fact that resolution is inversely proportional to resin particle diameter and directly proportional to column length was confirmed experimentally. The effects influencing resolution due to changes in flow rate of the mobile phase used are dependent on resin particle diameter. Changes in temperature affect a number of variables influencing resolution. (auth) (UK)

27211 TREATMENT OF RADIOACTIVE LIQUIDS. van de Voorde, Norbert (to Societe Belge pour l'Industrie Nucleaire). British Patent 1,188,396. 15 Apr 1970. Filed 11 Dec 1967.

The decontamination of radioactive liquids by ion exchange methods employing bitumen is described. The ion exchanger used is partially sulphonated bitumen of high specific surface area, and the bitumen is subsequently heat compacted to encapsulate the radioactive ions. The partially sulphonated bitumen is preferably fusible, and capable of being melted without decomposition or loss of material. Melting fixes the radioactive ions in an unleachable manner. Methods of preparing the partially sulphonated bitumen are described; the material may be used in the hydrogen form as obtained from the sulphonation reaction or in the sodium form. The bitumen can be used in the form of grains or powder, as a porous body, or thin sheets or strips, in conventional ion exchange installations. It is also possible to fix the sulphonated bitumen on particles of fresh bitumen or other similar products, or even to enclose particles of fresh bitumen completely with sulphonated bitumen before use. (UK)

27212 PROCESSING RADIO-ACTIVE WASTE OF THE NUCLEAR POWER PLANT AT DODEWAARD. Verziji, A. F. Polytech. Tijdschr. Elektrotech. Elektron.; 23: 647-52(13 Sep 1968). (In Dutch).

Analysis of various types of waste material from nuclear power plants, solid materials of low activity, solid wastes (e.g., resins of higher activity mixed with liquids and liquid wastes), and also the storage tank, filtering and transport system of the waste processing plant are discussed. (UKAEC Info. Bulletin)

27213 CHEMICAL AND ISOTOPIC EQUILIBRIA INVOLVING LIQUID AND GASEOUS NITROGEN OXIDES. Ishida, Takanobu (Brooklyn Coll.); Spindel, William. J. Chem. Eng. Data; 15: 107-14(1970).

Existing experimental data dealing with liquid-gas-phase equilibria among the oxides of nitrogen (NO, NO_2, N_2O_3, and N_2O_4) were re-examined, and an improved method was developed for calculating the gas-phase composition for a given liquid phase and temperature. The method was used to calculate chemical compositions in such systems over a wide range of temperature and total pressure. The effective single-stage separation factor for concentrating ^{15}N by this exchange system was also evaluated over a broad range of operating conditions. (auth)

27214 SOLUBILITY OF ^{85}Kr IN SOME ORGANIC SOLVENTS. Yamamoto, Yutaka; Takeda, Hiroshi (Tokyo Univ.). Tokyo Daigaku Kogakubu Kiyo, A; No. 7, 44-5(Dec 1969). (In Japanese).

Radioactive isotopes of noble gases such as Kr and Xe must be be removed from off-gas streams during reactor emergencies and normal large-scale fuel reprocessing operations. Of known processes for removal of these gases, selective absorption of noble gases in some organic solvents has the advantage of concentrating noble gases to high levels in a continuous process despite of its disadvantages of radiation damage to the solvents and relatively high percentage loss of solvents. Three kinds of solvent, i.e., carbon tetrachloride, kerosene, and freon 12 were chosen in view of their cohesive energy density values. Since Xe is more soluble than Kr, Ostwald absorption coefficient values of ^{85}Kr from dilute $Kr-N_2-O_2$ gas mixture systems were measured. Experimental data can be correlated by modified Prausnitz's equation based on the Hildebrand's regular solution theory. (auth) (NSA of Japan)

27215 APPARATUS FOR INCREASING THE CONCENTRATION OF A LESS VOLATILE LIQUID FRACTION IN A MIXTURE OF LIQUIDS. (to Pactide Corp.). British Patent 1,189,608. 29 Apr 1970. Priority date 1 Nov 1967, United States.

An apparatus is described for concentrating one liquid in a mixture of two liquids in which one is more volatile than the other with particular application to the concentration of heavy water from a mixture with ordinary water. The apparatus comprises a number of thin membranes assembled face to face with channels between to form a column and each membrane is perforated by a multiplicity of microscopic gas-filled passages capable of passing the vapors of the liquids while preventing the passage of the liquids. The mixture is introduced between a pair of membranes between the ends of the column and flows as a thin film between successive pairs of membranes toward one end of the column. The mixture is withdrawn from the column near one end. Heat can be transferred to the film near either end or near both ends to produce a temperature difference across each membrane causing part of the more volatile liquid on the hotter side of each membrane to evaporate and pass through the membrane. The mixture withdrawn at one end of the column thus has an increased concentration of the less volatile component. (B.L.M.)

27216 PROCESS FOR SEPARATION OF NIOBIUM AND TANTALUM. Stevenson, Franklin Dee; Conway, John E. (to U. S. Atomic Energy Commission). U. S. Patent 3,508,862. 28 Apr 1970. Filed 4 Aug 1967.

Niobium was separated from Ta by passing a gaseous mixture of the pentachlorides heated to 350 to 400°C under anhydrous conditions over a bed of a mixture of CaO and CaF_2 heated to 350 to 400°C. The Ta reacts to form a solid that remains on the bed, and the Nb is recovered in a condenser as the volatile niobium oxychloride. (B.L.M.)

27217 ENTRAPMENT OF RADIOACTIVE WASTE WATER USING SODIUM BORATE. Kausz, Ivan; Kim, Jong-dok (to Siemens Aktiengesellschaft). U. S. Patent 3,507,801. 21 Apr 1970. Priority date 19 Feb 1968, Austria.

A process and apparatus for final concentration and storing of radioactive waste water is described. The process is applicable to waste waters already containing sodium borate or to other waste waters to which sodium borate may be added. The borate-

containing water is thickened by heating until the remaining quantity of water corresponds to the one bondable to the sodium borate as water of crystallization and then cooling the concentrate to effect crystallization of the sodium borate. (B.L.M.)

27218 STUDIES ON THE REMOVAL OF RADIOACTIVITY FROM WATER. Kobayashi, Ugoro (Niigata Univ., Nagaoka, Japan); Ozeki, Saburo. J. Jap. Water Works Ass.; No. 417, 30-7(Jun 1969). (In Japanese).

The decontamination of radioactive waters was studied using radioisotopes. Test samples were prepared by adding radioisotopes to raw water from the Shinano River; and $Al_2(SO_4)_3$ was added as a flocculating agent. As the radioisotope, hydrochloric acid solutions of ^{137}Cs, and nitric acid solutions of fission products were used, and diluted to 200,000 cpm/ml. Muddiness was produced artificially in the raw water. With the same muddiness, ^{137}Cs was removed better than the fission product; possibly because the pH in fission product samples was lower than in ^{137}Cs samples. Assuming the rate of removal was influenced by the muddiness, the fission products were removed well at low values of the muddiness, compared with the case of ^{137}Cs, while at the high values, the removal rate was not much increased. In general, the rate of removal increased in both cases with the muddiness of samples. This is probably because radioisotopes were absorbed in the muddy material and consequently removed as the flocs. When the muddiness was high in samples, muddy material in the supernatant fluid increased, and the removal rate by filtration was raised. (NSA of Japan)

27219 PRECIPITATION OF QUADRIVALENT ACTINIDES BY SALTS OF QUATERNARY AMMONIUM BASES. Nikol'skii, B. P.; Posvol'skii, M. V.; Markov, G. S. At. Energ. (USSR); 27: 566-7(Dec 1969). (In Russian).

Precipitation from highly acid solution as a nitrate complex is a selective method of isolating the quadrivalent actinides. The salt is precipitated in the form of the compound $R_2[M(NO_3)_6]$. Here R is the cation of the quaternary base, and M is the actinide metal in quadrivalent form. Optimal conditions of precipitation are 6 to 8M nitric acid, and 0.05 to 0.2M quaternary ammonium base at room temperature. The solubility of the complex nitrate salt decreases with decreasing cation radius on going from Th^{4+} to Pu^{4+}. Dimethyldibenzyl ammonium (DMDBA) and benzylquinolinium (BQ) compounds are used as precipitants. The solubility of the thorium nitrate salt of DMDBA is 1.5×10^{-6} mole/l at a DMDBA excess of 0.04M. Thus, since the precipitate forms crystals which are large in size and constant in composition, it is easy to separate thorium from solution in a form suitable for weighing. Experiments with ^{152}Eu tracer show that it is possible to isolate quantitatively 2 g/l of thorium as the BQ salt from 7.0M nitric acid solution with less than 0.5% europium as a contaminant from initial solutions containing 1×10^{-6} to 18 g/l of europium. Iron, chromium, manganese, copper, etc., also have no effect on the completeness of separation or purity of thorium. (TTT)

27220 EXTRACTION OF TRIVALENT ACTINIDES AND EUROPIUM WITH 1-PHENYL-3-METHYL-4-BENZOYLPYRAZOLONE-5 SOLUTIONS IN THE PRESENCE OF CERTAIN DONOR-ACTIVE SUBSTANCES. Chmutova, M. K.; Kochetkova, N. E. Zh. Anal. Khim.; 25: 710-14(Apr 1970). (In Russian).

The distribution coefficients for trivalent Am, Cm, Bk, and Eu increase appreciably on adding tributyl phosphate (TBP) or trioctylphosphine oxide (TOPO) to 1-phenyl-3-methyl-4-benzoylpyrazolone-5 (PMBP) solutions in cyclohexane. The extraction of Am, Cm, Bk, and Eu by solutions of PMBP–TBP and PMBP–TOPO mixtures in cyclohexane was examined in relation to TBP concentration (for all the elements), TOPO concentration (for Am, Cm, Eu), and PMBP and HNO_3 concentrations (for Cm and Eu). All the elements are quantitatively extracted from 0.1N HNO_3 with a mixture of 0.05M PMBP–0.25M TBP or a mixture of 0.05M PMBP–0.0025M TOPO in cyclohexane. A mixture of 0.05M PMBP–0.025M TOPO quantitatively extracts Cm and Eu from 0.3 and 0.4N HNO_3, respectively. Taking Cm and Eu as an example, the composition of the extracted compound for PMBP–TBP mixtures was established as $MeA_3 \cdot 2TBP$. The extraction of two compounds $MeA_3 \cdot 2TOPO$ and $MeA_2(NO_3) \cdot 2TOPO$ is assumed on the basis of literature data and data obtained by the authors. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 27106, 27218, 27270, 27353, 27459, 27460, 27462, 27486, 28033, 28883, and 28934.

27221 (SZS-19/69) FALLOUT RADIOACTIVITY SURVEILLANCE OF WATERS IN THE GERMAN DEMOCRATIC REPUBLIC, 1961–1968. Kunert, J.; Schneider, D. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Nov 1969. 41p. (In German). Dep. CFSTI (U. S. Sales Only).

The results of an eight-year monitoring period of fallout radioactivity in waters of the German Democratic Republic (GDR) are presented and discussed. Main topics are: The development of the monitoring program, the changes of beta radioactivity concentrations in waters taking into special consideration the Elbe River, the relation of these changes to those of fallout radioactivity, the changes of the beta radioactivity concentration in the Elbe River on passing the territory of the GDR, dissolved and suspended radioactivity, and the effect of water flow and of the absorption of fallout radionuclides by the soils of the drainage area. Finally, from the viewpoint of radiation protection an evaluation is made of the observed concentrations of beta radioactivity and conclusions are drawn with regard to the continuation of monitoring fallout radioactivity in waters under varying fallout conditions. (auth)

27222 (WASH-1061(Suppl.)) NATURAL ENVIRONMENTAL RADIOACTIVITY. An Annotated Bibliography. Klement, Alfred W. Jr. (Nevada Operations Office (AEC), Las Vegas). Apr 1970. 72p. Dep. CFSTI.

A bibliography on natural environmental radioactivity is presented which contains more than 1000 references. The material is divided into seven categories: general, atmosphere, biological materials, soils, general waters, and groundwater with each category alphabetized by author. (L.C.L.)

27223 NEUTRON ABSORPTION LOGGING WITH THERMAL NEUTRON-CAPTURE GAMMA RAYS HAVING ENERGIES OVER 2.2 MeV. Seevers, Delmar O. (Chevron Research Corp.). U. S. Patent 3,508,052. 21 Apr 1970. Filed 27 Mar 1962.

A method for identifying oil and water interfaces behind a steel casing in a well bore is described. A fast neutron source is used, and the rate of absorption of the neutrons that are thermalized by fluids within the well bore and the surrounding earth formations to generate thermal-neutron-capture gamma radiation in chlorine nuclei is detected. By using gamma radiation with energy above 2.2 MeV the detection of salt is made insensitive to capture gamma radiation generated by hydrogen nuclei in the well bore, or in salt water or oil in the formation. The rate of decay of thermal neutrons is then measured by recording the total number of gamma rays detected in two different counting periods after the neutron source is cut off. (R.C.K.)

27224 CHEMICAL ANALYSES AND ELECTRON MICROPROBE STUDY OF SAMPLES OF GRANITE SUBJECTED TO AN UNDERGROUND NUCLEAR EXPLOSION. Faure, Jean (CEA, Paris); Ginglinger, Bernard. Compt. Rend., Ser. D; 270: 901-3(16 Feb 1970). (In French).

The diffusion of elements around the cavity created in granite by an underground nuclear explosion is defined by chemical analysis and electron micro-probe examination. (auth) (France)

27225 TRITIUM STUDY OF THE DYNAMICS OF UNDERGROUND WATERS. Hubert, Pierre (Centre de Recherches Geodynamiques, Thonon-les-Bains, France); Olive, Philippe; Siwertz, Erik; Marce, Adrien. Compt. Rend., Ser. D; 270: 908-11(16 Feb 1970). (In French).

A simple mathematical model by which the dynamics of underground waters may be accounted for on an annual scale is presented. With a known input program consisting of the isotopic characteristics of the rainfall which contributes to replenishing the water tables, this model can be used to determine the corresponding isotopic characteristics at the outlet of the drainage basin. The validity of the model is measured by the agreement between the calculated and observed outputs. It has been applied to the Rhône, Dranse, and Loire basins. (auth) (France)

27226 URANIUM AND THORIUM IN TEKTITES. AN ADDITIONAL COMMENT. Morgan, J. W. (Univ. of Kentucky, Lexington). Contract NAS 9-8017. Earth Planet. Sci. Lett.; 8: 141-2(Apr 1970).

The relationship between uranium and thorium in tektites and achondrites is reconsidered in the light of the oxygen isotopic composition of lunar rocks. A correlation is found between the uranium and thorium abundances in three high ^{18}O achondrites and those in tektites which is particularly strong in the case of the Australasian group. (auth)

27227 EFFECT OF STRAIN ON FISSION-TRACK AGES OF TEKTITES. Durrani, S. A.; Hancock, D. A. (Univ. of Birmingham, Eng.). Earth Planet. Sci. Lett.; 8: 157-62(Apr 1970).

Spurious tracks in unirradiated tektite sections can seriously affect the ages determined by the fission-track analysis method. It is shown that strain can cause spurious tracks which resemble the genuine fission tracks under certain circumstances. Methods of eliminating such errors are described. (auth)

27228 RADIOISOTOPE AGE DETERMINATIONS OF LAKE RUDOLF ARTEFACT SITE. Fitch, F. J. (Birkbeck Coll., London); Miller, J. A. Nature (London); 226: 226-8(18 Apr 1970).

The isotopic technique adopted in the study described is stated to be a new application of $^{40}Ar/^{39}Ar$ age determination. The material examined consisted of samples of a volcanic tuff and of pumice lumps in a calcareous matrix. It is pointed out that even if samples of pyroclastic rocks are fresh and otherwise suitable for K/Ar age determination a number of additional sources of error may be present, of which one of the most intractable is the possible presence of extraneous Ar derived from inclusions of pre-existing rocks: from preliminary studies it was clear that an extraneous Ar age discrepancy was obtained for the samples examined. Both total degassing $^{40}Ar/^{39}Ar$ and $^{40}Ar/^{39}Ar$ age spectra determinations were made on the samples. Argon-40/-39 geochronometry is based on the conversion of a portion of the natural ^{39}K present in a rock or mineral sample to the artificial ^{39}Ar by neutron irradiation. The ^{39}Ar yield for a particular neutron dose is proportional to the K content of the sample, and a value for the proportionality constant can be derived from the ^{39}Ar yield in standard samples irradiated to the same neutron dose. After an appropriate irradiation, measurement of the Ar isotope ratios present in the sample and a standard, using a high resolution mass spectrometer, is all that is necessary for complete total degassing geochronometric analysis. The mass of the sample or standard does not enter into the calculation. Very small and/or inhomogeneous samples, and samples of very low K content, can be dated by this method. Argon-40/-39 age spectrum geochronometry is a development of the $^{40}Ar/^{39}Ar$ dating technique in which the isotopic composition of the gas released from an irradiated sample of the rock or mineral is analysed repeatedly over a series of heating steps towards complete fusion. When a sample of uniform age is analyzed by this method a very accurate multipoint K-Ar isochron age is obtained, and when a sample of mixed age is analysed an age spectrum is obtained. The method can be a very powerful geochronological tool. Results for the samples investigated are shown tabulated; their age appeared to be 2.6 Myr. (UK)

27229 AIRBORNE MEASUREMENTS OF TERRESTRIAL RADIOACTIVITY AS AN AID TO GEOLOGIC MAPPING. Pitkin, James A. U. S., Geol. Surv., Prof. Pap.; No. 516-F, 1-29(1968). (GS-P-516-F).

Airborne measurements of terrestrial radioactivity (aeroradioactivity) were interpreted by correlation with areal geology. Rock-unit classification provided guidelines to the varying amounts of uranium, thorium, and potassium in the surface rock and soil which generated the measured gamma radiation. Correlations made between patterns of aeroradioactivity and geology were an aid to geologic mapping. About 200,000 square miles in the conterminous United States and Puerto Rico was surveyed for aeroradioactivity to determine background datum levels of environmental radioactivity around nuclear facilities. The aeroradioactivity data were obtained with continuously recording detection equipment which included a multicrystal array. Corrections were made for cosmic and aircraft background and for variations from the 500-foot terrain clearance elevation. Topography, lithology, and soil were dominant factors controlling aeroradioactivity interpretation. Topographic relief should not exceed 1,000 feet because natural radioactivity cannot be accurately measured when the airborne detector is more than 1,000 feet from ground surface. Varying bedrock lithology with consequent radioisotope variation resulted in the varying patterns of aeroradioactivity that were required for successful correlation. Homogeneous distributions of radioisotopes as measured by the scintillation detector gave vague and discontinuous patterns of aeroradioactivity that seldom had correlative value. For successful correlation the material at ground surface must reflect bedrock composition. Residual soils were ideal for correlation, although transported soils that did

reflect composition of the underlying bedrock were satisfactory. Where bedrock was covered by transported soils having a different composition, or by alluvium, loess, and under some circumstances glacial debris, correlation was usually impossible. Examples of correlation are discussed within a general framework of physiographic provinces which include: the Piedmont and the Valley and Ridge provinces; the Coastal Plain, Columbia Plateaus, Great Plains, and Pacific Border provinces; glaciated terrain of the midwest and northeast United States; and Puerto Rico. The Piedmont province was the ideal locale, where relief was within desired limits, rocks were lithologically varied, and soils were residual. Aeroradioactivity studies can supplement geologic mapping, which is hampered by sparse outcrops, structural complexities, and a general lack of fossils. In other areas, where circumstances are less than ideal, evaluation of correlation requires analysis within the given framework, noting the effect of topography, lithology, and soil. Aeroradioactivity surveys when combined with aeromagnetic and (or) electromagnetic surveys, in areas where the magnetic or conductive rock has a surface expression, are extremely effective facets of geophysical exploration. The Geological Survey is calibrating and flight testing an airborne gamma-ray spectrometer system. Delineation of gamma-ray energies with this equipment will permit estimations of the relative contribution of the uranium, thorium, and potassium components of terrestrial radioactivity. (auth)

27230 ESR DETECTION OF FOSSIL ALPHA DAMAGE IN QUARTZ. McMorris, D. W. (TRW Systems Group, Redondo Beach, Calif.). Nature (London); 226: 146-8(11 Apr 1970).

During the application of ESR techniques to the thermoluminescence (TL) dating of quartz a signal was observed which was not regenerated by ^{60}Co γ doses as high as 10^7 R after annealing at 500°C. Accumulated lattice damage caused by traces of U and Th seemed to be responsible. The signal was observed in a number of igneous, sedimentary, pegmatitic, and metamorphic quartz, and in an alpha active obsidian. It was not evident in specimens of hydrothermal quartz, into the lattices of which U and Th are not accepted on formation. Estimations were made of the natural formation rate of centers giving rise to such signals, and it seemed that the natural defect levels were below the detection threshold of any technique except ESR. The relevance to TL dating is discussed, with examples. Among other things, a comparison of natural and induced signal intensities might offer special advantages over fission track counting in the case of finely divided material such as lunar dust. The chief limitations are the effects of interfering signals, and, the effects of compositional variations, such as glasses. (UK)

27231 PRIMENENIE METODOV ATOMNOI I YADERNOI FIZIKI V GORNOM DELE. (Applications of Nuclear Methods and Nuclear Physics in Mining). Rzhevskii, V. V. (ed.). Moscow; Izdatel'stvo Nauka (1969). 207p.

Equipment and methods utilizing gamma radiation in the mining industry are described. Methods for the checking and control of the composition of substances, application of radiation in research and development of useful mineral deposits, automatic control of mining machines, determination of the age of rock, and the measurement of the ash content of coal, are discussed. (tr-auth)

Meteorology

Refer also to abstract 27222, 27336, 27593, 29045, and 29046.

27232 (AD-695733) ESTIMATION OF THE COEFFICIENT OF MERIDIANAL MACROTURBULENT DIFFUSION IN THE EQUATORIAL STRATOSPHERE ON THE BASIS OF RADIOACTIVE PRODUCT CONTENT OF NUCLEAR EXPLOSIONS. Karol, I. L. Translated from Tr. Inst. Prikl. Geofiz.; No. 8, 49-53(1967). 13p. (FSTC-HT-23-528-69). CFSTI.

According to published results of aircraft and balloon measurements of the concentration of strontium-90 and manganese-54 in the equatorial stratosphere (17 to 37 kilometers), the quantity of isotopes borne through this zone during 1963 and 1964 was determined, also the main value of the interlatitude gradient of their average concentration for the same period. These values make it possible to evaluate the average magnitude of the coefficient of meridian large-scale turbulent exchange in the equatorial stratosphere in 1963 and 1964. (auth) (USGRDR)

27233 (AD-698441) INVESTIGATION OF THE DISTRIBUTION OF CHARGES FOR "FREE" SHORT-LIVED RADON DECAY PRODUCTS. Serdyukova, A. S.; Savenko, E. I. Translated by Richard S. Relac from Izv. Vysah. Ucheb. Zaved., Geol. Razved.; 10: No. 8, 116-22(1967). 14p. (NRL-Trans-1166). CFSTI.

A review of published literature shows that the short-lived products of radon decay can exist in two states: elementary ions or "free" atoms (uncombined atoms), and atoms deposited on aerosol particles found in the air. There are two methods for determining the content of "free" atoms in the air: Precipitation by diffusion and in an electrical field. The results of a study of the distribution of charges among the "free" products of radon decay under various conditions of their existence are discussed. (auth) (USGRDR)

27234 (CONF-690540–, pp 22-31) CRITERIA FOR THE RELEASE OF RADIOACTIVE MATERIALS FROM NUCLEAR PLANTS WITH THE ATMOSPHERE. Vogt, K. J. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

The release of radioactive materials from the stack of a nuclear power plant is computed for normal operation as well as for accidental excursions. The effects on the surroundings are assessed for various meteorologic conditions. The emitted isotopes are divided into three groups; the first group acts mainly by inhalation, e.g., ^{131}I; the second group is hazardous because of its external γ radiation and is composed of most of the noble gases as well as of radionuclides with a half-life below 10 minutes. The third group is represented by nuclides that are predominantly β-emitters and that are not absorbed by the human body. It suffices to establish safety criteria for one representative of each group, because corresponding values for other group members can then easily be computed. Results are presented in three figures and four tables. (H.B.G.)

27235 (CONF-690540–, pp 32-42) DEFINING MAXIMUM PERMISSIBLE VALUES FOR THE LEAKAGE OF RADIOACTIVE MATERIALS IN AIR. Koenig, L. A. (Kernforschungszentrum, Karlsruhe (West Germany)). (In German).

Radiation burden to the population adjacent to a nuclear power plant is predominantly caused by release of radioactive material through the atmosphere. Two mechanisms are involved: continuous release of small amounts of radioactivity due to activation of the cooling air and minor leakages in closed circuits; and sudden and transient releases of higher amounts of radioactivity caused by the exchange of fuel elements and incidents during the handling of used fissionable material. Measures required to avoid sudden transient peaks of release are economically prohibitive. Therefore, the mean value for a given time period should be taken as a practical criterion. It is shown that outside of a circle with a radius of 2 km around the nuclear power plant, environmental radioactivity corresponds to normal values. (H.B.G.)

27236 (CONF-690540–, pp 97-103) METEOROLOGICAL MEASUREMENTS IN THE FRAMEWORK OF ENVIRONS MONITORING AT THE JUELICH NUCLEAR RESEARCH CENTER. Polster, G. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

To assess the radiation hazard to the population living near the Juelich Nuclear Research Center, a systematic analysis of meteorological conditions was compiled for the years 1965 through 1968. Categories for mean values of diffusion and horizontal and vertical wind fluctuations as a function of wind velocity are presented in three tables. (H.B.G.)

27237 (CONF-690540–, pp 104-12) RADIOACTIVITY MONITORING AT CERN. Prantl, F. A.; Baarli, J. (European Organization for Nuclear Research, Geneva (Switzerland)). (In German).

CERN has one 600 MeV synchrocyclotron and one protonsynchrotron with an energy of 28 GeV. The effects of the accelerators upon their environment were studied by systematic measurements of radioactivity in soil, air, and drainage system. Methods and equipment used in the monitoring program are described. The results showed that scattering radiation rapidly decreased with distance from the accelerators; at the boundary of the CERN area the radiation intensity was approximately twice the normal background values. It was concluded that the effects of the accelerators on air and drainage water are insignificant from a health-hazard standpoint. Further studies were suggested. (H.B.G.)

27238 (CONF-690540–, pp 184-96) RAPID IDENTIFICATION AND ACTIVITY DETERMINATION OF LONG-LIVED ALPHA EMITTERS IN AIR. Winkler, Raimund; Hoetzl, Helmut; Sansoni, Bruno (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Strahlenschutz). (In German).

A method is described for rapidly measuring the radioactivity of α-emitters with long half-life in air. Aerosol samples were electrostatically deposited on aluminum plates and these, in turn, were counted with a large surface grit ionization chamber. Within 4 to 6 hours following sampling, ^{239}Pu, ^{241}Am, ^{237}Np, and other α-emitters with long half-life were determined. The concentrations were 10 to 100 times lower than the maximum permissible concentrations in air for professional personnel. (H.B.G.)

27239 (NP-18197) DIVISION OF METEOROLOGICAL PHYSICS ANNUAL REPORT, 1968–69. (Commonwealth Scientific and

Industrial Research Organization, Melbourne (Australia). Div. of Meteorological Physics). 31p. Dep. CFSTI (U. S. Sales Only).

A brief summary of meteorological physics in Australia on the fundamental processes and the application of this knowledge to economic importance is given. General circulation and radar meteorology are discussed for dynamic and synoptic meteorology. Ozone behavior, distribution, and other observations, and radioactivity and volcanic dust as atmospheric tracers are also discussed. Other areas included are micrometeorology and agricultural meteorology, including evaporation. The development of instruments and procedures is reported. (J.C.W.)

27240 (NYU-3673-4) TRANSVERSE JET PLUMES. Technical Progress Report, January 1, 1969–January 31, 1970. Halitsky, James; Kaplin, Edward J. (New York Univ., N. Y. Geophysical Sciences Lab.). Contract AT(30-1)-3673. 27p. Dep. CFSTI.

Wind tunnel tests were conducted to measure plume concentrations in a low-turbulence, steady air stream. Preparatory work included manufacture of a support rig for holding multiple sample probes, design and construction of a recording ohmmeter for rapid impinger analysis, and development of a new calibration curve for the shorter sampling period. A mathematical model has been written to generate a time mean plume for a turbulent atmospheric wind, using the low turbulence wind tunnel concentrations. (J.C.W.)

27241 IONIZATION OF THE AIR DUE TO BETA- AND GAMMA-RADIATIONS NEAR THE GROUND. I. Kawano, Minoru (Nagoya Univ., Japan); Ikebe, Yukimasa; Nakashima, Yoshiyuki; Sekiguchi, Nobutada; Nakayama, Takeyoshi. J. Radiat. Res.; 10: 139–44(Sep-Dec 1969).

The ionization of near-ground atmosphere by beta and gamma radiation was measured in and around Nagoya during the last four years (1963 to 1966). Although the ionization by beta particles decreased gradually from 1963 through 1965, that by the gamma radiation did not decrease remarkably. Therefore, the contribution of the beta particles to the ionization of the air exceeded that of the gamma radiation from 1963 through 1964, while the latter exceeded the former in 1966. In general, the ionization by the beta particles from the ground surface covered with the grass exceeded that from the bare ground because of the fallout radioactivity accumulated in the leaves and roots of the grass. (auth)

27242 IONIZATION OF THE AIR DUE TO BETA- AND GAMMA-RADIATIONS NEAR THE GROUND. II. Kawano, Minoru; Nakashima; Yoshiyuki; Ikebe, Yukimasa; Shimo, Michikuru (Nagoya Univ., Japan). J. Radiat. Res.; 10: 145–50(Sep-Dec 1969).

The results of the measurements of ionization due to beta and gamma radiations near the ground surface from 1967 through 1969 are reported, and are discussed comparing with those obtained from 1963 through 1966. The ionization due to the beta particles decreased gradually, and the mean value for this period is about 1 J at one meter above the ground surface, and that by the gamma-radiation (including the cosmic rays) is almost constant, i.e., 5 ~ 6J. In January 1967, a sudden increase of the ionization due to the fallout radioactivity caused by the 5th Chinese nuclear explosion test was observed. Cesium-137, $^{90}Sr + {}^{90}Y$, ^{106}Ru, and ^{144}Ce were detected from the grass and soil samples taken on the campus of this university in 1964. Cerium-144, ^{140}La, ^{95}Zr, ^{132}I, and ^{132}Te were also detected from the fallout particles caused by the 3rd Chinese nuclear explosion test on May 9, 1966. (auth)

27243 DETERMINATION OF THE EQUAL-CONCENTRATION CURVES IN THE AIR AROUND A CONTINUOUS RELEASE OF A RADIOACTIVE EFFLUENT, ON THE BASIS OF THE METEOROLOGICAL INFORMATION COLLECTED ON SITE. Cagnetti, Pietro (Casaccia Nuclear Research Center, Italy). G. Fis. Sanit. Prot. Radiaz.; 12: 239–51(Oct-Dec 1968). (RT/PROT-(69)37).

An expression is developed for calculating the curves of isoconcentration in the air at ground level due to a prolonged and constant release of a gaseous contaminant, when direct recordings of wind speed and direction at the release point are available and when the stability category can be evaluated at the same time. Pasquill's formula and dilution graphs, which are valid for releases of a few minutes' duration, are adapted to the expression obtained, previously reduced in the form suitable for summary, so that reference can be made to short time intervals. The expression thus obtained is used to calculate the curves of isoconcentration in the air at ground level at the Casaccia Center, for a year-round continuous and constant release of a gaseous radionuclide. The results obtained are critically analyzed and compared with those found with simpler and more commonly used methods. (auth)

27244 RADIOACTIVITY OF THE ATMOSPHERE. Csongor, Eva (Inst. of Nuclear Research, Debrecen, Hungary). Fiz. Szemle; 20: No. 2, 36–41(1970). (In Hungarian).

The many radioactive isotopes in the atmosphere include natural radioactive materials, substances of cosmic origin, created by the interaction of cosmic radiation with the gases in the atmosphere and artifical radioactive materials, resulting from human activity. Among the natural materials, radon is the most important; its mean concentration is about 10^{-10} Ci/m^3, amounting to 100 decays per minute per kg of air. The actual radon content at a given location depends on the wind velocity and the temperature gradient of the area. In cities it is higher because of the radium in the coal burned in power plants. The cosmogenic nuclides include ^{14}C, ^{39}Ar, ^{7}Be, and ^{3}H. The ^{14}C is widely used for age determination. The ^{14}C content undergoes an approximate 10,000 year fluctuation; a shorter fluctuation cycle exhibits anticorrelation with the sunspot activity. As the result of weapons testing, about 200 radioactive isotopes were released into the atmosphere. Of the long half-life isotopes, ^{85}Kr is of special importance; at present, the total ^{85}Kr content of the atmosphere is estimated at 55 MCi. The chief source of supply is release from fuel reprocessing plants and not from operating reactors. Although the activity keeps increasing, it does not represent a serious radiation burden because it amounts to only 0.03 mrem/year and thus is negligible. (TTT)

27245 REGULARITIES OF DISTRIBUTION OF THE PRODUCTS OF RADON DECAY HIGH IN THE ATMOSPHERE AND THE VALUE OF VERTICAL TURBULENT DIFFUSION. Styro, B. I.; Chkhenkeli, Sh. M.; Tavartkiladze, K. A.; Khundzhua, T. G. Soobshch. Akad. Nauk Gruz. SSR; 54: 321–5(1969). (In Russian).

The vertical turbulent diffusion coefficients k_z were determined from vertical profiles of natural radioactivity due to the short-lived radon series, measured by means of a special aircraft, for both the average for the entire lower troposphere and for its individual layers. (Geophys. Abstr.)

27246 METEOROLOGICAL STATION AT JEN FOR THE STUDY OF ATMOSPHERIC DIFFUSION. PART II. ASSOCIATED ELECTRONIC INSTRUMENTS AND ANALYSIS OF THE DATA OBTAINED. Alonso, A.; Diez-Moreno, A.; Munoz, J. I.; Sanchez-Izquierdo, J.; Tapia, J.; Trueba, P.; Warzanskyi, W. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid); 13: 337–48(Jul-Aug 1969). (In Spanish).

The operational principle and the circuits of the analog computer for meteorological observations (CADOM-1), filter to obtain typical deviations (FODET-2), and an automatic digital recorder of meteorological observations (RADOM) are presented. (J.S.R.)

27247 FRACTIONATION PROPERTIES OF NUCLEAR DEBRIS FROM THE CHINESE TEST OF 24 DECEMBER 1967. Sisefsky, Jan; Persson, Gunnar (Research Inst. of Swedish National Defence, Stockholm). Health Phys.; 18: 347–56(Apr 1970).

Debris from China's seventh nuclear explosion test was examined with γ-spectrographic and autoradiographic methods. The hot particles were rather uniformly reddish, with a specific activity in the medium range. They displayed a normal fractionation, but the fractionation factors were independent of particle size in the range 0.4 μm to 4.5 μm. Debris, dissolved in precipitation water, displayed an opposite fractionation and it was found that the hot particles and the soluble particulate were mirror particulates, i.e., they represented the parts of a dual partition of the nuclear debris, originally formed. The distribution of various γ-emitting nuclides between the two particulates was calculated. The hot particles were found to have incorporated about 90% of all atoms of mass-chain 95 formed. It was estimated that 3.2×10^3 kg of iron per kg burnout uranium were incorporated in the fire-ball. Particle size spectra for different hot particle samples are given. The concept of mirror particulates and the particle formation model of Holmberg–Andersson are discussed. (auth) (UK)

27248 ARTIFICIAL ATMOSPHERIC RADIOACTIVITY: ITS GRANULOMETRIC DISTRIBUTION. Renoux, A.; Charfi, F. (Faculte des Science, Tunis). J. Rech. Atmos.; No. 4, 301–8 (Oct-Dec 1968). (In French).

Studies relating to artificial atmospheric radioactivity were surveyed. The results obtained about fractionation of particle radioactivity according to their size were compared to those of different authors. The orders of magnitude of the artificial and natural activity of air are indicated. (Meteorol. Geoastrophys. Abstr.)

Mineralogy and Exploration

27249 (CNEA-256) STUDY OF THE URANIUM-BEARING PEGMATITES OF THE MOUNTAINS OF COMECHINGONES, CORDOBA PROVINCE. Rinaldi, Carlos A. (Comision Nacional de

Energia Atomica, Buenos Aires (Argentina)). 1969. 56p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

Twelve pegmatites were studied in detail in 500 km² of the Comechingones district in the southern part of the Sierra Grande Mountains, Córdoba Province. The country rock is principally Precambrian schistose mica gneiss consisting of biotite, quartz, and oligoclase and some accessory tourmaline, garnet, and apatite. Small lenses of amphibolite and carbonate rocks are included in the mica gneiss. In the northeast corner of the area, about 10 km² contains the southwestern part of the Achala batholith. Many well-zoned pegmatites containing chiefly feldspar, muscovite, and quartz occur in the metamorphic rocks of the area, but many of these pegmatites are not now of economic value. The district has been divided into five areas of pegmatites of which only 3 have economically valuable minerals—chiefly muscovite, and some tantalum–niobium minerals, beryl, and uranium minerals as by-products. The pegmatites are generally lenticular or tabular and the bodies are 30 to 600 m long and 10 to 100 m thick. The emplacement of the pegmatites was structurally controlled by the host rocks. Commonly the pegmatites have at least two zones, but some have more. Recognized zones include border, wall, as many as 3 intermediate zones, and a core zone. There is also some telescoping of zone. The zones generally are not concentrically complete. Most commercial muscovite is mined from outer zones. The uranium minerals generally are associated with muscovite and punch-size sheets of muscovite in the core. Comechingones pegmatites were emplaced by displacement of the host rocks, permissive emplacement, and mobile fluids. Orientation of xenoliths suggests that the pegmatitic fluid entered preexistent open spaces. At the beginning of crystallization, the spaces were effectively sealed and then crystallization proceeded in a closed system. (auth)

27250 DEVELOPMENT OF RESEARCH IN RADIOACTIVE MINERALS. Tamayo, Juan Martin-Delgado (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid); 13: 312-22(Jul-Aug 1969). (In Spanish).

The studies of Antonio Carbonell during the 1930's on the presence of radioactive minerals in the Spanish peninsula are summarized. The evolution of the genetic and geological concepts of radio-uraniferous deposits is discussed with emphasis on the Spanish deposits. The investigation and exploitation of Spanish uranium deposits are described. The future market for uranium and the presently known uranium reserves are considered. (J.S.R.)

27251 RADIOACTIVE-ELEMENT CONTENT OF KIMBERLITES FROM THE SIBERIAN PLATEAU. Akimov, A. P.; Semenov, G. S. (All-Union Scientific Research Inst. of Nuclear Geophysics and Geochemistry, Moscow). Dokl. Akad. Nauk SSSR; 190: 947-50(1 Feb 1970). (In Russian).

The literature does not contain references concerning the presence of radioactive elements in kimberlites. In petrological studies, certain minerals, such as perovskite or apatite, which are known to contain radioactive elements, were found occluded in kimberlites. These findings lead to a study of the distribution of radioactive elements in kimberlites, measuring the concentration of uranium, thorium, and potassium by γ spectrometry. Contrary to the generally accepted opinion, it was found that the kimberlites possessed much higher radioactivity than the surrounding trap-rock. The concentration is an intermediate one, close to that of alkaline magma from the Plateau, lying between alkaline, basaltoid series of the activation zone and carbonatites. (TTT)

Seismology

27252 (CGS-746-2) RULISON SEISMIC EFFECTS. Navarro, R.; Wuollet, G. (Coast and Geodetic Survey, Las Vegas, Nev. Special Projects Party, Coast and Geodetic Survey, Rockville, Md.). 16 Feb 1970. 145p. (PNE-R-23). Dep. CFSTI.

The Rulison seismic signal was recorded in the distance range of from 4.29 to 366.3 km at 42 seismograph stations. The stations spanned four states with 84% of the stations located within a 145 km radius of ground zero in Colorado. The nuclear explosive had a yield of 40 kt (plus 20 or minus 4 kt). The recorded high frequency particle velocities were as predicted. The best general expression for the maximum trace earth particle velocities recorded on hardrock satisfied the following formula: $V = 547R^{-1.82}$. Readily identifiable impulsive elastic waves with their arrival times are given. An average apparent propagational velocity of 5.2 km/sec for the initial p-phase was calculated in a range of 4.29 to 366.3 km. The earthquake occurrence rate of 0.7 earthquakes per day during the two months of recording after the event compared favorably with the 0.6 earthquakes per day before the event. (J.C.W.)

27253 (JPRS-50421) MAGNITUDE METHOD FOR IDENTIFYING UNDERGROUND NUCLEAR EXPLOSIONS. Pasechnik, I. P.; (and others). Translated from Izv. Akad. Nauk SSSR, Fiz. Zemli; No. 1, 28-36(Jan 1970). 14p. CFSTI.

Statistical data on the relation between the magnitude, Ms, of surface waves and the magnitude, m_b, of P waves from earthquakes and underground nuclear explosions recorded at seismic stations in the USSR were analyzed. It was concluded that, for equal values of m_b, the Ms values for earthquakes are 0.5 to 1.5 units greater than the Ms values for underground explosions, and that this magnitude method can be used to differentiate between earthquakes and underground nuclear explosions. (L.C.L.)

27254 (NVO-1163-206) ANALYSIS OF GROUND MOTIONS AND CLOSE-IN PHYSICAL EFFECTS, RULISON EVENT. Foote, R. Q.; Cassity, C. R.; Loux, P. C.; O'Brien, L. J.; Power, F. W.; Hays, W. W.; Lynch, R. D.; Perchalski, F. R.; Spiker, C. T.; Whipple, A. P. (Environmental Research Corp., Alexandria, Va.). Apr 1970. Contract AT(29-2)-1163. 182p. (PNE-R-27). Dep. CFSTI.

The Rulison event, a 40 kt Plowshare nuclear detonation in the Rulison gas field of the Piceance Creek Basin, Colorado, provided an opportunity to analyze the ground motions and the close-in physical effects of a deeply buried detonation. Ground motions were recorded at 36 sites over a distance of about 4 to 367 km. These data were evaluated. The primary conclusions are: First, the level of the peak vector velocities and displacements observed from Rulison agree with the predicted levels. However, the peak vector accelerations are slightly higher than predicted. The observed peak vector accelerations and velocities significantly exceed the level expected from a normally buried 40 kt contained device detonated on the Nevada Test Site (NTS). Second, the PSRV spectra calculated from Rulison ground motions agree well with the spectra predicted on the basis of scaling theory, accounting for differences in yield and device depth of burial. The peak spectral response exhibits a higher level and occurs at shorter periods (0.1 to 0.4 second) than that of the spectral response expected from a normally buried 40 kt contained device detonated on the Nevada Test Site. (auth)

27255 (UCRL-50763) SPECTRAL COMPOSITION OF SEISMIC SOURCE FUNCTIONS ASSOCIATED WITH SOME REPRESENTATIVE NUCLEAR DETONATIONS. Roberts, John E. (California Univ., Livermore. Lawrence Radiation Lab.). 10 Nov 1969. 186p. Dep. CFSTI.

Fourier analyses of reduced displacement potentials and body-wave particle-displacement, particle-velocity, and particle-acceleration source functions are given for some representative nuclear detonations scaled to various yields. Possible consequences to the problems of analyzing distant detonations and predicting damage from nearby detonations are discussed. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 27224, 27252–27255, 27296, 27307, and 27308.

27256 (CONF-680334–1) NUCLEAR EXPLOSIVES FOR OIL AND GAS STIMULATION AND SHALE OIL RECOVERY. Coffer, H. F. (CER Geonuclear Corp., Las Vegas, Nev.); Higgins, G. H. (California Univ., Livermore. Lawrence Radiation Lab.). 1968. 36p. Dep. CFSTI.

From 8th Annual Meeting on Exploration and Economics of the Petroleum Industry, Dallas, Tex.

Projects underway for demonstrating the uses of underground nuclear explosions for stimulating the production of oil and gas and for the recovery of oil from oil shales are reviewed. The nuclear effects, explosion phenomena, radiation hazards, seismic effects, and costs are discussed. It is concluded that the potential problems appear to be solvable and that it should be possible to harness the power of the nuclear explosive for these peaceful applications in the very near future. (L.C.L.)

27257 (SC-DC-70-4836) BUILDING RESPONSE TO UNDERGROUND DETONATION. Ellett, D. M. (Sandia Labs., Albuquerque, N. Mex.). [1969]. 14p. (CONF-700509–1). Dep. CFSTI.

From Spring Meeting of the American Society of Civil Engineers, Los Alamos, N. Mex.

A review is given of the most widely used methods of predicting the response of buildings to underground detonation and the damage which results. The methods discussed are: use of peak values of expected acceleration, velocity, and displacement; use of predicted response spectra for large areas of coverage (i.e., cities) and for individual buildings of high monetary value; and use of the shock signature and a mathematical building model. The peak values method is used for screening large areas of low population density for possible damage. The use of the response spectra permits a simplified analysis for either large build-up areas or for individual expensive buildings, these being two areas of particular concern to the AEC. The shock signature method has been used only rarely on very critical applications because of the difficulty of modeling buildings adequately and the expense of such a study. A short discussion is given of the application of these prediction methods to Plowshare detonations. (auth)

27258 (TID–25402) PROJECT PAYETTE: PHASE I, A STUDY OF THE TECHNICAL FEASIBILITY OF CONSTRUCTING A LARGE CAVITY IN TATUM SALT DOME. (Fenix and Scisson, Inc., Tulsa, Okla. Petroleum Consultants, Houston, Tex.). 6 Nov 1967. Contract AT(26-1)-38. 242p. Dep. CFSTI.

Project Payette is proposed to test the decoupling theory. A summary is given of the technical feasibility of constructing a generally spherical cavity having a minimum interior dimension of the magnitude of 300 feet, deep in an intruded halite deposit (salt dome). The information covered in the study includes site formation, stability, cavity access, conventional mining, solution mining, and salt disposal. The principal conclusion reached is that the technical feasibility of constructing a cavity of the size and at the depth required for Project Payette by either conventional mining or solution mining methods cannot be determined until the theory of stability of large underground openings at great depths is proven by test and demonstration. Other specific conclusions are also given. (J.C.W.)

27259 (UCRL–50530(Rev.1)) SCHOONER PRESHOT ANALYSIS. Lessler, R. M. (comp.) (California Univ., Livermore. Lawrence Radiation Lab.). Nov 1968. 50p. Dep. CFSTI.

Schooner is a proposed underground nuclear detonation in tuffaceous rock for the purpose of expanding understanding of both nuclear cratering and the release of radioactivity by cratering detonations of intermediate yield. The crater left by Schooner is expected to have a radius on the order of 100 m and depth of about 70 m. The radiation field produced by fallout (infinite exposure from time of arrival) is predicted to be 0.5 R/hr about 15 miles downwind of ground zero. Information on the geology and material properties of the Schooner Site, emplacement and stemming plan, fallout and cloud radioactivity of the nuclear device, cratering calculations, and the experimental measurements is appended. (J.C.W.)

27260 EDUCATION FOR PEACEFUL USES OF NUCLEAR EXPLOSIVES. Symposium Held at Tucson, Arizona, March 31–April 2, 1969. Weaver, Lynn E. (ed.). Tucson, Ariz.; University of Arizona Press (1970). 356p. (CONF-690312).

Thirty-one papers were presented at the conference. A separate abstract was prepared for each of 25 papers. Five papers have appeared previously in NSA. The remaining paper contains a summary of the conference from the point of view of the educator. (L.C.L.)

For abstracts of individual papers see: 27261–27285.

27261 NATIONAL POLICY ON PEACEFUL USES OF NUCLEAR EXPLOSIVES. Tape, Gerald F. (Atomic Energy Commission, Washington, D. C.). pp 3-9 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The policy of the U. S. government on peaceful uses of nuclear explosives, Project Plowshare, is explained. The national policy is set by the AEC and includes: restriction to the government of the development, control, and use of nuclear explosives; responsibility for the health and safety of the public; involvement of industry in applications such as the recovery of natural resources; and promotion of international cooperation. The significance of these policies is discussed briefly, and the importance of education to the successful utilization of nuclear explosives for the benefit of mankind is mentioned. (L.C.L.)

27262 TECHNOLOGICAL DEVELOPMENT OF NUCLEAR EXPLOSIVES ENGINEERING. Johnson, G. W. (Gulf General Atomic Inc., San Diego, Calif.). pp 11-21 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

Activities in the Plowshare Program, initiated in 1957 to develop peaceful uses of nuclear explosives, are reviewed. Since that time the USAEC has detonated more than 200 underground explosions in Nevada plus events in Alaska, Mississippi, and New Mexico. The results of specific cratering and underground-contained tests are discussed in terms of excavation achieved, radiological hazards, and seismic effects. Recommendations are made for furthering the industrial development and public acceptance of nuclear explosions engineering. (L.C.L.)

27263 FUTURE CONTAINED NUCLEAR EXPLOSIVES EXPERIMENTS. Coffer, H. F.; Higgins, G. H. pp 45-63 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

Specific Project Plowshare experiments such as Bronco, Dragon Trail, Ketch, Rulison, and Sloop are described briefly, and the possibilities of making these particular applications of underground nuclear explosions economically feasible are presented. (L.C.L.)

27264 THE CORPS OF ENGINEERS' NUCLEAR CONSTRUCTION RESEARCH PROGRAM. Hughes, Bernard C. (Univ. of California, Berkeley). pp 81-103 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The joint research program of the U. S. Army Corps of Engineers and the USAEC conducted since 1962 to develop the basic technology necessary to use nuclear explosives in the construction of large-scale civil engineering projects is reviewed with reference to cratering phenomena and techniques, nuclear quarrying and ejecta dams, and nuclear excavation for canals and harbors. (L.C.L.)

27265 NUCLEAR EXPLOSIVES IN WATER RESOURCE DEVELOPMENT. Piper, Arthur M. (Geological Survey, Washington, D. C.). pp 105-111 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The potentials, economic advantages, and limitation of using underground nuclear explosions in the development and management of water resources are discussed briefly. (L.C.L.)

27266 NUCLEAR TECHNOLOGY. Talley, Wilson K. (Univ. of California, Davis/Livermore). pp 133-41 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The technology needed in nuclear explosives engineering is defined as the skills and information required to design, emplace, monitor, and fire the explosive and to ensure the radiological safety of the reentry and the subsequent use of the region affected by the explosion. Each of these aspects, categorized as preshot activities, detonation and range effects, and postshot activities, and the use of nuclear explosions as a neutron source is discussed. (L.C.L.)

27267 HYDRODYNAMICS. Leith, C. E. (National Center for Atmospheric Research, Boulder, Colo.). pp 143-8 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

Proper planning of the use of nuclear explosives for excavation or cratering requires a means of predicting the associated earth motions. In order to obtain more detail than is available from empirical scaling laws, numerical simulations of the motions by computer models can be developed which are based primarily on the physical laws of hydrodynamic motion. How such models are constructed, some of their limitations, and their requirements in computing capacity are presented. (L.C.L.)

27268 SEISMIC SIGNAL AND STRUCTURAL RESPONSE. Blume, John A. pp 149-71 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

In order to reliably predict the seismic effects of underground nuclear explosions and to develop the technology needed to control the seismic risks, the Effects Evaluation Division of the USAEC Nevada Operations Office conducts a continuing program for collecting and evaluating seismic data. Some of these data on ground motions, response spectra, and building response and damage for particular underground nuclear events are presented, and research efforts for using this data to evolve new methods for predicting seismic risks are discussed. (L.C.L.)

27269 AIRBLAST FROM PLOWSHARE PROJECTS. Reed, Jack W. (Sandia Corp., Albuquerque, N. Mex.). pp 173-92 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

Airblast predictions and monitoring are necessary to ensure the safety of populated areas distant from the blast source. Occasionally, the atmosphere acts as a lens for focussing blast waves and can result in more blast force at greater distance than would be expected under normal atmospheric conditions. The blast effects of airburst and underground explosions are discussed. Data on blast propagation from particular explosions and on window breakage from small-amplitude airblast waves are presented. It is concluded that more research on long-range airblast propagation in the atmosphere is necessary. (L.C.L.)

27270 GROUNDWATER CONTAMINATION. Stead, Frank W. (Geological Survey, Washington, D. C.). pp 205-20 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The effects of underground nuclear explosions on ground water contamination are reviewed by considering radioisotopes of biological significance, the initial distribution around the point of explosion, and the transport of radioisotopes by ground waters. Studies conducted by the USAEC to determine the amount and distribution of radioisotopes in the hydrologic environment are the basis for this review. A method for calculating the initial distribution of biologically significant radioisotopes around a large underground nuclear explosion is presented. It is concluded that beyond moderate distances, ground water flows are not radically changed by an underground nuclear explosion; given the geologic and hydrologic conditions, it is possible to estimate the rates and concentrations of radioisotope transport by ground water; practically all geologic environments will retard the transport of ^{90}Sr but will have little effect on tritium transport; tritium is the most important radioisotope in ground water safety considerations and its concentration is mainly diluted by hydrodynamic dispersion; the contamination of water supplies by ground water transport of underground nuclear explosion-produced radioisotopes is predictable and manageable. (L.C.L.)

27271 LIMITED TEST BAN TREATY AND CIVIL NUCLEAR ENGINEERING. Ehrlich, Thomas (Stanford Univ., Calif.). pp 223-30 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The Limited Test Ban Treaty of 1963 exempts only those underground nuclear explosions which do not cause fallout beyond the borders of the state causing the explosion. The legal implications of the treaty conditions to large civil engineering projects, such as the excavation of a tunnel near an international boundary or of an interoceanic canal are discussed. It is concluded that solving the legal problems in this case may be as difficult as developing the technology of nuclear explosives. (L.C.L.)

27272 PLOWSHARE PROGRAM DEVELOPMENT ACTIVITIES. Clark, Fred J. (Atomic Energy Commission, San Francisco). pp 231-8 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The development and growth of a program to provide information about activities in Project Plowshare to the scientific community are summarized. (L.C.L.)

27273 A SURVEY OF UNIVERSITY COURSES IN NUCLEAR CIVIL ENGINEERING. Kruger, Paul (Stanford Univ., Calif.). Contract AT(04-3)-326-PA15. pp 239-56 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

In September 1968 a survey was conducted to determine the status of nuclear explosives engineering as an academic subject. Preliminary results showed that 16 universities in the US now offer regular credit courses exclusively devoted to nuclear explosives engineering, that 6 universities include this subject matter within other regular courses, and that 4 more have such courses in the planning stage. (L.C.L.)

27274 NUCLEAR EXPLOSIVES ENGINEERING AT MICHIGAN. Kammash, T. (Univ. of Michigan, Ann Arbor). pp 257-63 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The University of Michigan graduate study course on peaceful uses of nuclear explosives is described. An outline of the course content and a short discussion of some of the reference materials used are presented. (L.C.L.)

27275 NUCLEAR EXPLOSIVES ENGINEERING AT THE UNIVERSITY OF ARIZONA. Keller, Keaton (Univ. of Arizona, Tempe). pp 265-7 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The University of Arizona study course on nuclear explosive engineering is briefly described. (L.C.L.)

27276 NUCLEAR EXPLOSIVES ENGINEERING AT THE UNIVERSITY OF CALIFORNIA, DAVIS. Talley, Wilson K. (Univ. of California, Davis/Livermore). pp 269-72 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The three courses in nuclear explosives engineering given at the University of California, Davis, are briefly described. (L.C.L.)

27277 INSTRUCTIONS IN APPLICATIONS OF NUCLEAR DEVICES AT IOWA STATE UNIVERSITY. Murphy, Glenn (Iowa State Univ., Ames). pp 281-3 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

A course in nuclear explosives engineering given at Iowa State University is briefly described. (L.C.L.)

27278 NUCLEAR EXPLOSIVES ENGINEERING AT STANFORD UNIVERSITY. Kruger, Paul (Stanford Univ., Calif.). pp 285-90 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The development and content of the nuclear explosives engineering course at Stanford University are described. (L.C.L.)

27279 UNIVERSITY ROLE IN NUCLEAR EXPLOSIVES ENGINEERING RESEARCH. Teller, Edward (Univ. of California, Berkeley). pp 293-8 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The role of the university in nuclear explosives engineering research is discussed in terms of the technical training required by Plowshare engineers, some specific peaceful uses of nuclear explosives, and the progress to date in making Plowshare information available to students. (L.C.L.)

27280 SCIENTIFIC APPLICATIONS OF NUCLEAR EXPLOSIONS. Brown, W. K.; Cowan, G. A. (Los Alamos Scientific Lab., N. Mex.). pp 299-311 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

Whenever nuclear explosions are used for engineering purposes, scientists can simultaneously try to use them to perform experiments in nuclear physics, nuclear chemistry, geochemistry, meteorology, seismology, and other disciplines. Examples of current scientific interests in nuclear explosions at Los Alamos, including time-of-flight neutron experiments and the production of heavy isotopes in nuclear explosions by multiple neutron capture on ^{238}U, are discussed. (L.C.L.)

27281 NEEDS OF GOVERNMENT AND INDUSTRY FOR TRAINED NUCLEAR EXPLOSIVES ENGINEERS. Vinciguerra, John V. (Atomic Energy Commission, Washington, D. C.). pp 313-18 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The present and future personnel needs and training requirements for nuclear explosion engineers are described. The roles of government agencies, particularly the AEC, industry, and the universities in meeting these requirements are discussed. (L.C.L.)

27282 EDUCATIONAL NEEDS OF INDUSTRY. Hilberry, Norman (Univ. of Arizona, Tempe). pp 319-26 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The types of university graduates needed by industry in the nuclear explosives field are discussed. (L.C.L.)

27283 UNIVERSITY–AEC COOPERATION. Beard, G. V. pp 329-32 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

Cooperation between the U. S. Atomic Energy Commission's Divisions of Nuclear Education and Training and Peaceful Nuclear Explosives and the universities is briefly discussed. One major reason for the failure to interest more university people in the programs for peaceful uses for nuclear explosives in that university people believe that such programs are essentially programs of technology and not of fundamental science, and that the AEC's application has been largely commercial, e.g., Project Gasbuggy, with very little fundamental interest being shown to the universities. It is hoped that the 1970's will bring a better understanding of where the universities should be headed in their interaction with the AEC, and that the AEC will find ways to improve its cooperation with the universities. (R.C.K.)

27284 CURRICULUM DEVELOPMENT. Witzig, Warren F. (Pennsylvania State Univ., University Park). pp 333-4 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The problems associated with the development of university curricula needed to educate engineers for peaceful uses of nuclear explosives are outlined. The ideas of four of the foremost men in the field of nuclear engineering curriculum development are presented. (R.C.K.)

27285 A LOOK INTO THE FUTURE FOR PLOWSHARE. Libby, W. F. (Univ. of California, Los Angeles). pp 335-9 of Education for Peaceful Uses of Nuclear Explosives. /Weaver, Lynn E. (ed.). Tucson, Ariz.; Univ. of Arizona Press (1970).

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz. See CONF-690312.

The future of the Plowshare Project is discussed in reference to past experiments, the growing international interest, the development of Plowshare devices, and the enthusiasm of personnel who have been working in the program. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 27314, 27473, 27734, 27900, 28137, 28151, 28183, and 28186–28188.

27286 (KURRI-TR-69) LOW TEMPERATURE IRRADIATION FACILITY OF THE KYOTO UNIVERSITY REACTOR (KUR): ITS CONSTRUCTION AND PERFORMANCE. Shibata, Toshikazu; Iwata, Shiro; Yoshida, Hiroyuki; Nakagawa, Masuo; Okada, Moritami; Atobe, Kouzo; Sagane, Toshimitsu (Kyoto Univ. (Japan). Research Reactor Inst.). 21 Oct 1969. 56p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

In order to study the effects of radiation damage, it is necessary to maintain the specimens at low temperatures during irradiation and measurements. Accordingly, a low temperature irradiation facility capable of sustained operation down to 10°K was constructed at KUR. The facility consisted of two major parts; one is an irradiation cryostat of which the head was located in a horizontal exposure hole of the reactor, and the other was a helium gas refrigeration system. An automatic temperature control system by an adjustment of the flow rate of the circulating helium gas was included in this facility. Flux distributions of gamma radiation, thermal, and fast neutrons at the head of the irradiation cryostat were measured. Safety analysis of the facility is discussed. Some experimental results on the physical properties such as electrical resistivity and internal friction of some metals and alloys both during and after irradiation at low temperature are also reported. (auth)

27287 (NP-18196) ANNUAL REPORT, 1968-69. (Weapons Research Establishment, Salisbury (Australia)). 50p. Dep. CFSTI (U. S. Sales Only).

Section headings for this report, following a general review, are Project and Research Facilities, Consultation and Services, and Equipment and Techniques. Information on external publications and Weapons Research Establishment staff is appended. (Australia)

27288 (TID-4103(Suppl.1)(Rev.1)) ENGINEERING MATERIALS LIST CUMULATIVE INDEX, 1968-1969. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). May 1970. 37p. DTIE Free.

A cumulative subject and corporate author index is presented, which includes all packages of engineering materials and specifications which were announced in the Engineering Materials List (TID-4100, Suppl. 43 through 55). A title list of packages arranged in CAPE-number sequence is also included. This publication supplements TIC-4103, June 1968, a cumulative index of engineering materials announced in TID-4100 through TID-4100, Suppl. 42. (J.C.W.)

27289 RADIATION-SHIELDING WINDOW CONTAINING SILICONE OILS BETWEEN FACING SHEETS. Sandore, Henry P. Jr. (to Corning Glass Works). U. S. Patent 3,505,525. 7 Apr 1970. Filed 25 Jan 1966.

The radiation-shielding window structure comprises a number of plates of transparent radiation-resistant glass in face-to-face relationship. A thin film of a silicone oil fills the space between the surfaces of adjacent glass sheets. The silicone oil is preferably a phenylmethyl or a methyl silicone oil. (auth)

27290 FUEL CASTING APPARATUS WITH COLLAPSIBLE CORE. Katz, Norman H.; Beam, Roger N. (to U. S. Atomic Energy Commission). U. S. Patent 3,506,235. 14 Apr 1970. Filed 12 Sep 1967.

A molding apparatus for casting annular uranium carbide and other nuclear fuel elements consists of a solid graphite rod within an annular graphite core. The core is designed to collapse upon cooling of a molded fuel, while the graphite rod serves as a heat sink for the mold to prevent premature destruction of the core. In one version the core and rod are separated by an air gap clearance sufficient to permit the molded fuel to contract when cooling without destroying the hollow core. In another version, the solid rod is sectioned and includes graphite spacer rings for permitting expansion and contraction of the rod sections to provide intimate thermal contact between core and rod when the fuel is molten,

while permitting contraction of the rod segments as the fuel cools. (auth)

27291 METHOD OF MOUNTING A BOOTING ON A CONNECTING MEMBER. Berger, Rene; Dujardin, Jean; Faudot, Gerard; Liebbrandt, Pierre; Sontag, Rene (to Commissariat a l'Energie Atomique). British Patent 1,188,053. 15 Apr 1970. Priority date 26 Jun 1967, France.

A method is given for mounting a sealing on a connecting apparatus which is connected to a manipulator arm. The device may be used in an inspection cell for radioactive articles. A locking bead is located in the groove of the conical outer surface of the annular device which fits into the complementarily shaped portion of the bore and then the bead may be snapped shut. (J.C.W.)

27292 GRIPPER FOR EBR-II FUEL UNLOADING MACHINE (18 Sep 1969) (Engineering Materials). (Argonne National Lab., Ill.). (CAPE-1995).

24 drawings.

A gripper mechanism used with the EBR-II fuel unloading machine (FUM) was modified to meet the increased operating requirements of the EBR-II now used as a fast-flux irradiation facility. The FUM, a self-propelled shielded cask traveling on rails, is used to transfer reactor subassemblies between the Na-filled primary tank and the interbuilding coffin. The gripper operates in a severe environment alternately immersed in circulating Ar gas at temperatures up to 650°F and in 700°F molten Na. The equipment is also exposed to trace amounts of moisture in interbuilding transfers. The gripper has the following four basic components: core or body, outer shell or jaw actuator, sensing rod, and a spring-loaded gas-cooled shell. The gripper moves vertically and opens or closes by means of a push-pull chain system consisting of two identical chains which can be wrapped in one direction. When the chains are placed back to back, they form a rigid bar-like structure which can exert push or pull forces together or separately. The chains are driven by drive sprockets, which rotate in opposite directions. These sprockets are geared to an electrohydraulic power unit which is part of the gripper-elevation-drive system. Sensing-rod position is transmitted by a sensing chain which is kept in tension by a spring-driven takeup drum. The chain passes over an idler sprocket, which meters the vertical movement of the chain and relays this information to the control panel. (For details see TID-4100 Suppl. 58) (F.S.)

27293 SOLUTION OF THE PROBLEM OF AIR EXCHANGE IN THE USE OF LARGE GAMMA INSTALLATIONS WITH AUTONOMOUS RADIATION PROTECTION. Sobol, N. V. (Inst. of Occupational Hygiene and Occupational Diseases, Moscow). Gig. Tr. Prof. Zabol.; 13: 39-41(Apr 1969). (In Russian).

Nitrogen oxides and ozone in concentrations exceeding allowable values can be formed by the effects of ionizing radiation on air in the working space of a gamma irradiator. The number of required air changes is given by the following equation: $K = 2 \times 10^{-13} A (V^{0.33}/V_1)(hr^{-1})$, where A is the gamma equivalent of the irradiator in gram-equivalents of radium; V and V_1 are the volumes of the working chamber, and of the installation respectively in m^3. If desired, the results can be multiplied by a factor of 0.7 to 0.9 to take into account the gamma radiation that is absorbed internally and that does not reach the air of the working chamber. A nomogram is presented that gives the number of air changes as a function of $V^{0.33}/V_1$ over a wide range of values of A, V, and V_1. (TTT)

27294 SUPERCONDUCTING Nb TM_{010} MODE ELECTRON-BEAM WELDED CAVITIES. Turneaure, J. P.; Nguyen Tuong Viet (Stanford Univ., Calif.). Contract Nonr 225(67). Appl. Phys. Lett.; 16: 333-5(1 May 1970).

Several superconducting TM_{010} mode Nb cavities at 8.6 GHz with high measured unloaded Q's and fields were made using commercial reactor-grade Nb, practical fabrication techniques, and practical processing techniques. The cavities were fabricated by machining the cavities in two parts from a solid billet of Nb and then joining the two parts with electron-beam welding. The cavities were processed primarily by using ultra-high-vacuum firing (1750-2100°C) and chemical polishing. Unloaded Q's as high as 10^{11} were measured at low field levels, and surface fields as high as 1080 Oe and 70 MV/m were obtained with unloaded Q's on the order of 10^{10}. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 29017 and 29090.

27295 (CTC-23) NUMERICAL DESCRIPTION OF SUBSONIC FLOW IN A TURBULENT COMPRESSIBLE BOUNDARY LAYER. Park, James E. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 28 Apr 1970. Contract W-7405-eng-26. 137p. Dep. CFSTI.

The use of digital computers to solve the fundamental equations of fluid mechanics is presently a developing art. Previously, the equations have been solved for particular flow situations (turbulent jets, vortex shedding, cellular convection and laminar separated flows, for example) using the time-marching or unsteady technique. An application of this technique to obtain a numerical description of the flow in a turbulent compressible boundary layer is described. A finite difference representation for the appropriate partial differential equations developed to describe the mean behavior of the turbulent flow has been solved for free stream Mach numbers of 0.13 and 0.6. An empirical model for the turbulent stress tensor is presented. The restrictions necessary for numerical stability are noted; in particular an implicit difference form for the time variable is required. Iteration techniques, handling of numerical boundary conditions and similar problems are discussed. Satisfactory agreement is obtained between correlated experimental data from the literature and calculated local values for Nusselt number and friction coefficient. Calculated velocity profiles through the boundary layer are compared with measurements from the literature for the lower Mach number flow. From these results, it is concluded that flow in a turbulent boundary layer can be described numerically using the time-marching technique. Therefore the range of applicability of the technique has been expanded. (auth)

27296 (UCRL-50801) DESCRIPTION OF THE TENSOR-PUFL FORTRAN PROGRAM. Barr, Leota K. (California Univ., Livermore. Lawrence Radiation Lab.). 19 Jan 1970. 16p. Dep. CFSTI.

Two finite-difference calculations (codes) are linked along a common boundary where each supplies the other with a boundary condition. One code (TENSOR) uses a pressure vs time and position boundary condition and supplies the other code (PUFL) with a displacement vs time and position boundary condition. A description is given of the TENSOR-PUFL link FORTRAN program. A detailed outline of the calculations, the logical flow of the linkage, and lists of PUFL input parameters are given. (auth)

Isotope Technology

Refer also to abstracts 27106, 27836, and 29066.

27297 (NP-18173) ENRICHMENT OF URANIUM BY THERMAL DIFFUSION. Cruz, Concepcion Morales (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Quimica). 1969. 61p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

A design for the enrichment of uranium by thermal diffusion is proposed. The design indicates the most convenient equipment and the subsequent operational problems for the enrichment of natural uranium (0.7% of ^{235}U) up to 2.1% ^{235}U. The theoretical results indicate that the operation in principle is simple, and the equipment requirements are very simple and can be easily fabricated in any institution or laboratory of limited resources. The installation is easy and does not require much horizontal space, only a space with sufficient height. For the thermal diffusion design, the temperatures, wire, and the tube were 298°K for the primary and 1073°K for the secondary loops. The electrical power necessary is 1.675 kW. The calculated cost was $8.55/g of UO_2. Construction of the thermal columns derived from the theory is under way. (J.S.R.)

27298 (UCRL-Trans-10463) RADIONUCLIDE BATTERIES. Euler, K. J.; Scharman, A.; Wegner, U. Translated by J. Silberstein for Univ. of California, Lawrence Radiation Lab., Livermore, from Elektrotech. Maschinenbau; 86: 463-72(Nov 1969). 38p. Dep. CFSTI.

Conversion methods and uses of radionuclide batteries are discussed. The conversion methods include: thermoelectric, thermionic, photoelectric, and dynamoelectric. The uses discussed include navigation at sea, navigation in air, meteorology, oceanography, telecommunications, cathode corrosion protection, and medicine. (J.C.W.)

27299 SECURITY SYSTEM UTILIZING PENETRATING RADIATION. Wright, Donald E.; Gibson, Andrew H. Garry (to Tyco Labs., Inc.). U. S. Patent 3,508,055. 21 Apr 1970. Filed 12 May 1966.

A security system is described for detecting the presence of intruders in an area under surveillance. A source of penetrating radiation is disposed at the perimeter of the area and a number of detectors are situated within the area. The detector output provides a measure of the radiation absorption by an intruder and thereby an indication of the identity of the intruder. (auth)

27300 ^{252}Cf AND ITS APPLICATIONS. Grugni, G.; Tonolini, F. (CISE, Milan). Energ. Nucl. (Milan); 17: 182-9(Mar 1970). (In Italian).

Californium-252 is an intense source of neutrons produced by spontaneous fission. Utilization of californium-252 in numerous fields of science and technology is foreseen. The properties of of this isotope are reviewed, an evaluation is given of its price and production trends at mean term, and a survey was made of its various potential applications. (auth)

27301 MEASURING THE INCOMBUSTIBLE CONTENT OF MINE DUST USING BACKSCATTER OF LOW ENERGY GAMMA RAYS. Stewart, Robert F.; Martin, Joseph W. (to Secretary of Interior). U. S. Patent 3,505,520. 7 Apr 1970. Filed 10 Oct 1967.

A method is described for finding the incombustible content of fine particles such as mine dust. Low energy gamma radiation is applied directionally to a layer of mine dust and the incombustible content is determined from the backscatter from this radiation. Details of the apparatus are given. The method facilitates the determination of the percentage of incombustible content without sampling and chemical analysis. (R.C.K.)

27302 INTERMITTENT POWER SOURCE. Winsche, Warren E. (to U. S. Atomic Energy Commission). U. S. Patent 3,504,494. 7 Apr 1970. Filed 28 Oct 1968.

A method of producing closed cycle high energy steam power from a low energy isotope source is given. The heat for steam production is gained by desorbing hydrogen from a first metal hydride bed onto a second metal hydride bed. Hydrogen recycling from the second to the first bed is heated by a low energy isotope source. (auth)

27303 ^{109}Cd SEALED SOURCES FROM A TARGET ACTIVATED IN THE EWA REACTOR. Poninski, Marek; Jurewicz, Andrzej (Instytut Badan Jadrowych, Swierk, Poland). Nukleonika; 14: 967-72(Oct 1969). (In Polish).

A method of preparing ^{109}Cd solid sources by cadmium electrodeposition has been developed. The radioisotope was obtained from a cadmium-108-enriched metal target, irradiated in the 8 MW EWA reactor. High purity of the radiation emitted and underformed shape of the energy spectrum were obtained. The activity of 1 cm^2 of the source surface was 35 mCi. Provisions have been made for obtaining sources of higher activity. (auth)

Materials Testing

Refer also to abstracts 27314, 27767, and 27773.

27304 (LA-4366-TR) RADIOGRAPHY OF HIGHLY ACTIVE IRRADIATED FUELS. Chassende-Baroz, Norbert; Hayet, Lucien. Translated for Los Alamos Scientific Lab., N. Mex., from Ind. At.; 10: No. 7/8, 87-91(1966). 4p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 45866. (G.M.C.)

27305 PERIODIC INSPECTION OF REACTOR VESSELS. Maroto, J. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid); 13: 351-60(Jul-Aug 1969). (In Spanish).

The code developed under the auspices of the International Atomic Energy Agency for the periodic inspection of reactor vessels is outlined. The necessity for such an inspection and the factors which can contribute to the failure of reactor vessels are described. Structural factors contributing to vessel failure and other possible causes of failure are discussed. The most common inspection methods are described. (J.S.R.)

27306 NUCLEAR AND RADIOGRAPHIC METHODS FOR THE STUDY OF CONCRETE. Bhargava, Jitendra (Kungliga Tekniska Hogskolan, Stockholm). Acta Polytech. Scand., Civil. Eng. Ser.; No. 60, 102p(1969).

Nuclear and radiographic methods were used for studying the factors which influence the properties of concrete cast in deep forms. Sedimentation of concrete in columns was studied by γ-ray transmission method; the variation in the moisture content along the height was studied by a neutron moisture gauge, and the distribution of cement was checked by tracer analysis. Zones of varying density and water content were observed in the columns, but there was no difference in cement content between the top and the bottom. Structure of concrete was studied by penetrant dyes and by contact radiography of thin slices. Microcracks were found in concrete before loading. Radiography was used also for studying the cracking in concrete prisms during loading. In light of the results of these studies, the relation between the strength and the structure of concrete was critically reviewed. (auth) (Sweden)

Protective Structures

Refer also to abstract 27257.

27307 (AD-700694) FIRE START CAPABILITIES OF NUCLEAR DETONATIONS IN URBAN AREAS: A PREDICTION MODEL. Progress Report. Bracciaventi, John (Naval Applied Science Lab., Brooklyn, N. Y.). 30 Sep 1969. Contract DAHC20-70-C-0230. 75p. (NASL-940-90-PR-4). CFSTI.

A method for predicting the distribution of primary ignitions in urban areas due to nuclear detonations is presented. The model calculates separately the number of expected ignitions in window fuel arrays, tinder fuel arrays interior to rooms, and exterior fuel arrays. Fuel distributions and distributions of urban characteristics are utilized in the calculation. Shadowing by buildings and obstructions, and attenuation by window panes and screens are considered. Fire-start capabilities of the ignitions are described by enumerating the ignitions by zones in each occupancy or use-class together with estimates of their burning times and fuel values. The fuel load in each zone due to major fuels and kindling fuels is also specified. (auth) (USGRDR)

27308 (AD-701354) LIMITING DAMAGE FROM NUCLEAR WAR. Brown, William M. (RAND Corp., Santa Monica, Calif.). Oct 1969. Contract F44620-67-C-0045. 104p. (RM-6043-PR). CFSTI.

Based on the current concept that nuclear attack would occur only after an international crisis, thus providing from several days to several months of strategic warning, it is maintained that damage limiting systems can be designed that would reduce present estimates of about 100 million fatalities by 90 percent. Two extreme programs are considered: a "cheap" program based on urban evacuation and improvised fallout shelters, and an "expensive" program based on urban blast shelters and active defense. (auth) (USGRDR)

Radioactive Material Handling

Refer also to abstracts 26995, 27234, 27235, 27332, and 27901.

27309 (ARH-1634) WEIGHTS OF CRITICAL SPHERICAL PLUTONIUM-SOLUTION SYSTEMS. Bleyckert, W. A. (Atlantic Richfield Hanford Co., Richland, Wash.). 31 Mar 1970. Contract AT(45-1)-2130. 6p. Dep. CFSTI.

A method of weighing waste cartons as they are being filled is described for use in monitoring spherical plutonium-solution systems. The minimum weights of critical systems (zero weight percent plutonium-240) were calculated and found to be a function of plutonium critical mass and a function of plutonium concentration. The minimum total weight of any critical solution system was found to be 42.5 pounds, including the reflector. Minimum weights of fissile solutions alone having one-inch water reflection or full water reflection, are 28.5 or 19.7 pounds, respectively. (J.C.W.)

27310 (BNWL-tr-49) SOLIDIFÍCATION OF HIGH LEVEL WASTES. PART 3. DIFFUSION AND ELUTION RATES OF RADIONUCLIDES INCORPORATED IN BASALTS. Ralkova, J.; Saidl, J. Translated by Elaine Foskett (Battelle-Northwest, Richland, Wash.), from Kernenergie; 10: 161-4(1967). 9p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 34430.

27311 (CEA-CONF-1430) PHYSICO-CHEMICAL PROCESSES OF TRANSFER OF RADIORUTHENIUM IN CONTINENTAL ENVIRONMENT. Bittel, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires); Blum, J. M.; Jaumier, J. J.; Verot, J. L. (Ugine-Kuhlmann S.A., Paris (France)). [1969]. 16p. (In French). (CONF-690918-3). Dep. CFSTI (U. S. Sales Only).

From Conference on Radioecology, Cadarache, France.

The physical chemistry of ruthenium is complicated because of the numerous valence states corresponding to salt combinations and complexes. Two radioisotopes of Ru with average life, ^{106}Ru and ^{103}Ru, are present in numerous liquid radioactive effluents. This is evidently the result of the difficulties of decontamination and is explained as a function of the physical chemistry of the element. Therefore, these Ru radioisotopes can contribute to the contamination of the continental environment. In liquid effluents and their emunctories, the radioisotopes have various physico-chemical states and it seems probable that the varied behavior of Ru in the dispersion medium is explained in part by differences between the physicochemical states of the element. The principal difficulties which the experimenter encounters are due to the varied behavior of solutions of radioruthenium used up to the present, to the multiplicity of the equilibria existing in dilute

solution between the different forms of Ru, and to the lack of fidelity of the data from the analysis. It is proposed to alleviate the first difficulty by operating with well defined compounds and the third by obtaining data complementing each other which will probably lead to interpretable data concerning the second. In the first phase of experimental work, well-defined compounds of radioruthenium were prepared. The conditions of use of these compounds are discussed as well as data to be attained from experiments using these compounds for the study of the transfer of radioruthenium into the continental environment. (tr-auth)

27312 (CONF-690540–, pp 43-56) THE QUESTION OF DEFINING THE HIGHEST PERMISSIBLE VALUES FOR THE RELEASE OF TRITIUM-CONTAINING WASTE WATER. Schwibach, J. (Bundesministerium fuer Wissenschaftliche Forschung, Bad Godesberg (West Germany)). (In German).

Tritium production and release are discussed for various types of reactors. Projection of the number of nuclear power stations to exist in Germany by 1980 leads to the conclusion that the release of power reactor waste water into major rivers like the Rhine and Elbe will result in hazardous tritium doses. Appreciable genetic damage would result from the use of these river systems as a potable water supply for the population mass in this area. The possibilities for reducing the radiation burden to the population by the injection of tritium into deep subsurface cavities, by collecting it in containers for submergence into the ocean, and by free release of tritium-containing waste water into the sea far from the shoreline are analyzed. (H.B.G.)

27313 (CONF-690540–, pp 57-75) PROBLEMS OF ENVIRONMENTAL HYGIENE IN THE USE OF RADIONUCLIDES IN RESEARCH, MEDICINE, AND TECHNOLOGY. Aurand, Karl (Bundesgesundheitsamt, Berlin (West Germany). Institut fuer Wasser-, Boden- und Lufthygiene). (In German).

One-hundred-sixty-seven questionnaires were sent to institutions using radioactive materials for technical studies, research, and medical applications. 109 answers were obtained and showed that procedures for radioactive waste disposal were generally too expensive and too elaborate. It was suggested that waste water enter a fair-sized containing vessel. After its filling, the solution should be stirred and its mean radioactivity determined. Simultaneously, the waste water should be switched to a second empty container and, after its filling, the procedure should be repeated. By alternating between the two containers, a reliable and economic assessment of radioactivity in waste water can be obtained. (H.B.G.)

27314 (CONF-690540–, pp 141-51) LEAK TESTING CONTAINERS AND CAPSULES FOR RADIOACTIVE MATERIALS. Kowalewsky, H.; Neider, R. (Bundesanstalt fuer Materialpruefung, Berlin (West Germany)). (In German).

The various methods for leak testing of containment vessels used for transporting radioactive materials are discussed. To compare these methods as to sensitivity and reliability, an experimental containment vessel with well-defined capillary holes was used. The results are presented in three tables and it was suggested that the IAEO directive with respect to the helium leakage test be modified. (H.B.G.)

27315 (CONF-690540–, pp 152-67) CONTAMINATION INCIDENTS, CAUSES, AND EFFECTS. Sauermann, P. F.; Schneider, Karin (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

From 1966 through 1968, 23 contamination incidents occurred at the Juelich Nuclear Research Center; reactor incidents were not included. The nature and extent of the 23 events are listed. Contamination originating from hot cells was caused mainly by careless performance of frequently repeated routine procedures. Contamination originating in research laboratories was caused mainly by poor preparation of experiments and by inadequate techniques for handling irradiated samples. Contamination originating in chemistry and physics laboratories handling low levels of radioactivity was caused predominantly by personnel inexperienced in coping with unexpected events. Of the personnel involved in these incidents, 100 showed contamination, 86 contamination of skin, and 21 incorporation of radioisotopes. Only one person received doses exceeding the maximum permissible limit but developed no clinical sequelae. (H.B.G.)

27316 (IN-1344) SECOND PROCESSING CAMPAIGN IN THE WASTE CALCINING FACILITY. Lohse, G. E.; Hales, M. P. (Idaho Nuclear Corp., Idaho Falls). Mar 1970. Contract AT(10-1)-1230. 48p. Dep. CFSTI.

For the first time, high-level radioactive zirconium fluoride wastes were calcined to solids in the Waste Calcining Facility as part of the second processing campaign. On this campaign which extended from April 1966 to March 1968, 880,000 gallons of aluminum fuel waste and 109,000 gallons of zirconium fuel waste were calcined in an air-fluidized bed heated to 400°C by means of a liquid metal heat transfer system. Calcination of the zirconium waste was a primary achievement because this waste contained substantial quantities of corrosive zirconium and aluminum fluorides. An overall operating on-stream time of 85.8% was achieved during the campaign. Decontamination of off-gas from the fluidized bed was excellent. (auth)

27317 (IN-1365) STUDY OF THE MIGRATION OF ^{137}Cs IN GRANULAR CALCINED RADIOACTIVE WASTES. Lakey, L. T.; Wilding, M. W.; Dickey, B. R. (Idaho Nuclear Corp., Idaho Falls). Mar 1970. Contract AT(10-1)-1230. 73p. Dep. CFSTI.

The migration of cesium-137 in granular product of the Idaho Chemical Processing Plant (ICPP) Waste Calcining Facility was measured, using a high-temperature furnace and gamma-ray spectrometer scanning system. Effective diffusivities ranging from 10^{-7} cm^2/sec at 900°C to 10^{-3} cm^2/sec at 1200°C were calculated from a mathematical model based on a constant diffusivity; however, the diffusivity was found to be a function of concentration. Gas flow increased the migration markedly; substitution of argon for the air atmosphere produced no change. The results implied that cesium will collect in a 625 to 750°C temperature band in storage bins, resulting in storage bin centerline temperatures below those calculated for homogeneous uniform heat source. Recommendations for further work on waste characteristics and experimental methods are given. (auth)

27318 (UCRL-19465) ENGINEERING STUDY OF RADIOLOGICAL FIRE PREVENTION AT LAWRENCE RADIATION LABORATORY, BERKELEY, CALIFORNIA. Young, Jensen (California Univ., Berkeley. Lawrence Radiation Lab.). Jan 1970. Contract W-7405-eng-48. 34p. (CONF-700514-1). Dep. CFSTI.

From American Industrial Hygiene Association Conference, Detroit, Mich.

Some of the engineering steps taken at the Lawrence Radiation Laboratory, Berkeley, California, to reduce the hazards of fire in radioisotope areas are discussed and evaluated. These include the selection of fire-retardant materials for enclosures to meet the variable and unpredictable demands of researchers, fire tests on enclosure components, modification and testing of a fire extinguisher for glove boxes, evaluation of radioisotope storage areas, and a critical look at mechanical ventilation in a radiological fire. (L.C.L.)

27319 PROCESS FOR DECONTAMINATING RADIOACTIVE FLUIDS. Lehmer, Wilhelm (to Linde Aktiengesellschaft). U. S. Patent 3,501,923. 24 Mar 1970. Priority date 14 Aug 1962, Germany.

A radioactively contaminated gas containing relatively adsorbable and less adsorbable radioactive impurities is continuously passed through an adsorber. The adsorber becomes saturated with the relatively adsorbable impurity, the saturated condition of the adsorber being effective to hold up the flow of contaminated gas and provide a residence time in excess of the half-life of the readily adsorbable impurity. The latter decays to a small fraction of its original radioactivity. The flow through the adsorber is continued for a prolonged period of time following saturation and the gas is recovered with substantially unchanged proportions of the original constituents, but with the readily adsorbable impurity being freed from radioactivity. The gas with reduced radioactivity is then liquefied and passed along an extended path where the less adsorbable impurity decays. (auth)

27320 DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTES IN CZECHOSLOVAKIA. Chorvat, Karol; Palák, Miroslav (Inst. for Research, Production, and Use of Radioisotopes, Prague). Jad. Energ.; 16: 133-4(1970). (In Czech).

A survey of the system of the preparation, transport, and disposal of low-level radioactive wastes from radioisotope laboratories is presented. The disposal and construction of the central burial site in the underground spaces are described. The safety and suitability of this method in Czechoslovak conditions was proven during the ten years of operation. (auth)

27321 TECHNIQUE FOR THE INVESTIGATION BY ELECTRON MICROSCOPY OF PARTICLE SIZES AND SHAPES IN POWDERS OF HAZARDOUS MATERIALS IN THE SIZE RANGE 0.05 TO μm. Sharpe, R. M.; Bramman, J. I. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Micron; 1: 192-200(1969).

A totally enclosed inert-atmosphere facility for the preparation and examination by electron microscopy of powder samples for particle characteristic investigations is described. Though originally developed for work on plutonium-bearing oxide samples, the facility has potential application to any reactive, toxic, radioactive or infectious material. Normal open-laboratory operation and maintenance of the microscope are not affected. (auth) (UK)

27322 INFLUENCE OF THE SURFACE ACTIVE AGENTS ON THE DECONTAMINATION EFFECT. Siemaszko, Aleksander (Instytut Badan Jadrowych, Warsaw). Nukleonika; 14: 951-65(Oct 1969). (In Polish).

The influence of the surface active agents on the decontamination factor of surfaces of different materials has been examined. It was found that the effectiveness of decontamination is due to the retention of the radioactive ions by the particles of the collectors (sorption on the micelles, ion exchange, or complexing). This retention as well as other interactions produces a decrease of the adsorption when the adsorbed ions are removed from the decontaminated surface. (auth)

Vacuum Engineering

Refer also to abstract 27472.

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 27099 and 27106.

General Detectors and Monitors

Refer also to abstracts 27238, 27452, and 28659.

27323 (AD-471483) RUGGEDIZATION AND STABILITY OF COUNTER AND INTEGRATOR TUBES. Interim Report No. 1. (Anton Electronic Labs., Inc., Brooklyn, N. Y.). 1952. Contract NObsr-57381. 26p. CFSTI.

The theory of the "threshold voltage drift function" for geiger tubes as put forward in Naval Research Laboratory Report 3948 is reviewed. Then the theory is applied to the counter and integrator tubes under development. (USGRDR)

27324 (AEEW-M-959) NOTE ON THE VACUUM PROCESSING OF MAGNESIA INSULATED CABLES AND ASSOCIATED COMPONENTS. McMinn, K. W. (Atomic Energy Establishment, Winfrith (England)). Feb 1970. 9p. Dep. CFSTI (U. S. Sales Only).

The emission of gases during the vacuum processing of mineral insulated cables is estimated. From a consideration of pumping speeds and desired pressures in a typical situation, conclusions on vacuum system requirements are drawn. These requirements are particularly needed for magnesia-insulated cables used with in-pile ionization chambers. (UK)

27325 (ANL-7615) RADIOLOGICAL PHYSICS DIVISION. Annual Report, July 1968-June 1969. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 233p. Dep. CFSTI.

For preceding report see ANL-7489.

Forty-six articles are included; separate abstracts were prepared for 26. Eight were presented as abstracts only of articles previously published. The remaining 12 articles that were not in scope for NSA contain information on: concentration of lead in human bone; variations in surface area and volume of bone in cross sections taken from a single human rib; development and healing of rickets in rats; meteorological studies on pollution; fluorescence polarization; and fluorescence characteristics of the p-oligophenylenes and their substituted analogs. (P.C.H.)

For abstracts of individual sections see: 27029, 27030, 27181, 27326-27331, 27478, 27499-27505, 27557, 27579, 27580, 27607, 27672, 28077, and 28089-28091.

27326 (ANL-7615, pp 1-3) APPLICATION OF CELLULOSE NITRATE FILMS FOR ALPHA AUTORADIOGRAPHY OF BONE. Cole, Alan; Simmons, D. J.; Cummins, Helen; Congel, F. J.; Kastner, Jacob (Argonne National Lab., Ill.).

Cellulose nitrate can be used to record the tracks of alpha particles from bone and may have some advantages over nuclear emulsions. The tracks are made visible by etching the cellulose nitrate film with NaOH and no darkroom is required. Beta rays and electrons do not produce tracks, so background fogging is eliminated. The etching process makes visible only those alpha particle tracks that penetrate the film, so the attainable resolution may be better than that of nuclear emulsions. Finally, the alpha tracks are enlarged and so may be more easily counted by a photoelectric scanner. (auth)

27327 (ANL-7615, pp 81-7) TIME-OF-FLIGHT GAMMA-RAY CAMERA OF LARGE DIMENSIONS. Marinelli, L. D.; Clemente, G. F.; Abu-Shumays, I. K.; Steingraber, O. J. (Argonne National Lab., Ill.).

The localization of low levels of radioactivity by means of time-of-flight techniques is possible if resolutions of the order of 5 cm are tolerated. A survey is given of the optical, electronic, and mathematical problems involved. (auth)

27328 (ANL-7615, pp 87-95) REGULARIZATION UNFOLDING IN LOW γ-RAY ACTIVITY MEASUREMENTS. I. EVALUATION FOR ONE-DIMENSIONAL SCANNING. Clemente, G. F.; Marinelli, L. D.; Abu-Shumays, I. K (Argonne National Lab., Ill.).

The problem of converting the spatial distribution of the counting rate of a scanning 3" NaI crystal to the distribution of radioactivity in the object being studied, involves solution of a Fredholm equation of the first kind. Precision of the results is studied as a function of the physical parameters used in the measurements. (auth)

27329 (ANL-7615, pp 95-7) REGULARIZATION UNFOLDING FOR TWO DIMENSIONS: PROGRESS REPORT. Abu-Shumays, I. K. (Argonne National Lab., Ill.).

A solution to a Fredholm equation of the first kind, relevant to a two-dimensional distribution of radioactivity is being sought by smoothing the experimental data by the use of approximately weighted smoothing matrices. The kernel is assumed to be Gaussian. (auth)

27330 (ANL-7615, pp 198-201) ENVIRONMENTAL NEUTRON MEASUREMENTS WITH SOLID STATE TRACK RECORDERS. Roberts, J. H.; Parker, R. A.; Congel, F. J.; Kastner, Jacob; Oltman, B. G. (Argonne National Lab., Ill.).

The suitability of using ^{10}B and ^{6}LiF in contact with cellulose acetate butyrate (CAB) for the measurement of slow neutron densities has been investigated. The upper energy threshold of clear Diacel cellulose nitrate (CN) and of the CAB have also been measured. The CAB in good contact with thick ^{10}B or ^{6}LiF sources offers good promise for the detection of slow neutrons. For the actual CAB samples used, the CAB-^{10}B combination had an efficiency of 1.3×10^{-2} tracks per thermal neutron incident in a 2π solid angle. The corresponding number for the CAB-^{6}Li combination is 5.6×10^{-3} tracks per thermal neutron. (auth)

27331 (ANL-7615, pp 228-9) EFFECT OF PRESSURE UPON IONIZATION IN PURE RARE GASES. Schultz, H. A. (Argonne National Lab., Ill.).

Components of the ion chambers designed to measure the effect of pressure upon the ionization of pure rare gases were cleaned, assembled, and checked for satisfactory operation. Several portions of the apparatus were modified because they were unsatisfactory in their original form. (auth)

27332 (CEA-N-1250) PHYSICAL AND ELECTRONIC CHARACTERISTICS OF CRITICALITY ALARM DEVICES. BEHAVIOR DURING ACTUAL CRITICAL POWER-RISES. Renard, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1970. 37p. (In French). Dep. CFSTI (U. S. Sales Only).

The detection and alarm devices for criticality accidents developed at the Commissariat à l'Energie Atomique consist essentially of neutron or gamma radiation detectors connected to a data processing system. The electronic characteristics of the detectors and the main results of the tests carried out using all available sources, make it possible to explain the operation of these detectors and also to deduce their sensitivity thresholds and their range of detection during an actual critical power rise. The introduction of the CRAC system (Radiological Consequences of Criticality Accidents) which is a full-scale reproduction of critical accident conditions in the liquid phase, has shown that a particular type of accident can occur which is not detected by the actual data processing systems. New solutions are proposed which are now being studied or are already being constructed. (France)

27333 (CEA-N-1261) CALIBRATION METHOD OF A NaI(Tl) DETECTOR. APPLICATION TO γ EMITTER DOSIMETRY IN GASEOUS PHASE. Berne, Roger; Derlot, Jean (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Jan 1970. 45p. (In French). Dep. CFSTI (U.S. Sales Only).

A general method for calculating the absolute total efficiency of a cylindrical NaI crystal is given for various geometries including a point source, line source, disk source, and cylindrical source. The photofraction of this crystal is determined experimentally. The product of the absolute total efficiency and the photofraction gives the absolute peak efficiency R of the crystal for those geometries. A graph of the variation of R with Ey (energy of the incident photon on the crystal) is presented. These curves are generally used to determine the quantity of radionuclides contained in a source of a given geometry when the corresponding reference source is unknown. Cylindrical gaseous sources are used, but reference sources are practically impossible to find. (France)

27334 (CONF-690540-, pp 168-73) USE OF A UNIVERSAL DETECTOR IN RADIATION PROTECTION IN NUCLEAR RESEARCH CENTERS. van Binsbergen, H.; Kowalski, E. (Landis und Gyr A.G., Zug (Switzerland)). (In German).

A radiation monitoring device for general application is described. It consists of a single channel analyzer to which various detectors can be connected by cables up to 100 m in length. As detectors, Geiger-Mueller tubes, scintillation crystals, proportional counters, semiconductor detectors, and neutron detectors are easily interchangeable. Thus, the device is suitable for α, β, γ, and neutron counting. The electronics of the apparatus are discussed as well as the economic advantages and the useability in both laboratories and reactor installations. (H.B.G.)

27335 (CONF-690540–, pp 174-83) A METHOD FOR DETERMINATION OF THE PERIODIC BEHAVIOR OF ^{222}Rn CONCENTRATIONS. Albrecht, E. (Gesellschaft fuer Strahlenforschung m.b.H., Frankfurt am Main (West Germany)); Kaul, A. (Freie Universitaet, Berlin (West Germany). Nuklearmedizinische Abt.). (In German).

A method for continuous recording of radon-222 is described. Its principle consists of the deposition of the first daughter product of radon, polonium-218, on the surface of an α-detector. By recording the activity of polonium-218, the radon concentration is easily determined. Suggestions for further improvement of the method are discussed and depicted. (H.B.G.)

27336 (CONF-690540–, pp 197-205) PROBE WITH ACTIVATED-CARBON PAPER FILTER FOR AIR MONITORING. Hemmerling, H.; Jung, D.; Schulze-Pillot, G. (Farbwerke Hoechst, Frankfurt am Main (West Germany)). (In German).

An apparatus is described for continuous monitoring of ^{131}I and ^{197}Hg activity in the air. Air samples are sucked through a probe with filter paper containing activated charcoal. 98% of the ^{131}I is retained on the filter, and its β-activity is counted and recorded with a rate meter. The filter is replaced daily. The same filter retains only 16% of mercury. By impregnation with iodine, 2 milligrams/cm^2, the retention rate is increased to practically 100%. If the air contains ^{131}I as well as ^{197}Hg, the normal filter as well as the iodine-impregnated filter are inserted into the probe and γ-counting is then performed. By recording the activity in the 2 corresponding channels of the analyzer, monitoring of iodine and mercury is performed separately and simultaneously. Diagram and electrical hookup of the probe are depicted. (H.B.G.)

27337 (CONF-690540–, pp 407-15) A MOBILE WHOLE-BODY COUNTER OF THE GSF. Hoetzl, H. (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Strahlenschutz). (In German).

A mobile whole-body counter was developed for routine monitoring of professional personnel and for use in the case of nuclear accidents. The counter itself, a small thyroid uptake station, and a dressing room were mounted on a truck with careful climate control. Details for shielding arrangements, the sodium iodide crystal, and the multichannel analyzer are depicted. Efficiency of the equipment was demonstrated by phantom measurements as well as by studies on personnel. (H.B.G.)

27338 (CONF-690540–, pp 416-22) CALIBRATION COMPARISONS OF WHOLE-BODY RADIATION MEASURING INSTALLATIONS IN THE COUNTRIES OF THE EUROPEAN COMMUNITY. Schmier, H. (Bundesgesundheitsamt, Berlin (West Germany)). (In German).

Cesium-137 and potassium content, as obtained by whole-body counting, was compared between various European research institutions. Reported values differed by as much as 30%. To determine whether the cause of the difference rested in the population or in the measuring technique, five persons of different constitutions were analyzed by all institutions. In eleven out of sixteen whole-body counters, potassium values agreed within ±10%; the remaining five counters required a correction factor. ^{137}Cs values agreed within ±10% for only nine institutions. The remainders required correction factors. To improve calibration, phantoms with known potassium and ^{137}Cs content were sent to the same research institutions. (H.B.G.)

27339 (CONF-690540–, pp 423-31) POSSIBILITIES OF THE INCORPORATION OF DATA PROCESSING EQUIPMENT FOR ANALYSIS OF WHOLE-BODY ACTIVITY MEASUREMENTS, ESPECIALLY IN ON-LINE METHODS. Koeppe, P.; Gutenmorgen, W. (Freie Universitaet, Berlin (West Germany)). (In German).

A computer program is described to evaluate the spectrum of a patient, ascertained by a whole-body counter. The program permits calibration with ^{226}Ra, storage of the patient's spectrum in the memory, integration of the spectrum, calculation of peaks with analysis of radioisotopes, and correction of drift. A schematic drawing of the system and samples of the computer program are included. (H.B.G.)

27340 (CONF-690540–, pp 432-8) SCINTIGRAPHIC RECOGNITION OF INHOMOGENEITIES OF ORGAN STORAGE BY OPTIMIZATION OF MECHANICAL-ELECTRIC PARAMETERS. Frost, Dietrich (Rudolf-Virchow-Krankenhaus, Berlin (West Germany). Abteilung fuer Strahlungsphysik). (In German).

To improve radioisotope color scanning, modifications in the electronic system were developed. In clinical tests, the new equipment proved its efficiency by a sharp outline of the organ under investigation and by better representation of pathologic details. Principles of the method are described and presented by a block diagram. (H.B.G.)

27341 (CONF-690540–, pp 505-9) CONSTRUCTION AND TESTING OF AN IONIZATION CHAMBER FILLED WITH AN ORGANIC FLUID. Staeblein, G. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). (In German).

An ionization chamber filled with extremely purified hexane was constructed and tested with ^{137}Cs, x radiation, and 14-MeV neutron radiation. Results showed that further extensive studies are required for practical application. (H.B.G.)

27342 (CONF-690540–, pp 510-16) USE OF NONPHOTOGRAPHIC NUCLEAR TRACK TECHNIQUES FOR DETERMINATION OF ALPHA ACTIVITIES. Burger, Georg (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Strahlenschutz). (In German).

For the measurement of α particles, plastic foils were used and etched under standard conditions for one hour in 30% KOH at 60°C. The technique has been used for radiography of fuel elements and barium-containing materials following neutron exposure; as a leakage test and general contamination test for α-emitters; and for determination of radon, thoron, and their decay products in mining personnel. Problems encountered in the experimental series are discussed and possible solutions proposed. (H.B.G.)

27343 (CONF-690540–, pp 538-47) A SENSITIVE SCINTILLATION DOSIMETER FOR RADIATION PROTECTION PURPOSES. Lauterbach, U.; Kolb, W. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). (In German).

Anthracene crystals were used with excellent results for γ-ray dosimetry in the energy range from 80 keV to 1 MeV. Below 80 keV, sensitivity fell off sharply. To compensate for this disadvantage, a thin layer of ZnS was applied to the surface of the anthracene crystal. This layer, approximately 10 mg/cm^2, showed maximal fluorescence around 30 keV. Consequently, the combination of a 10 mm thick anthracene crystal with ZnS coating showed dose values that varied not more than ±15% over an energy range from 22 keV to more than 1 MeV. Arrangement of detector, photomultiplier, and amplifier are described as well as various sensitivity ranges, temperature dependency, and time constants. (H.B.G.)

27344 (DP-1202) DUAL-CHANNEL LOG COUNT RATE METER. Woodward, William J. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar 1970. Contract AT(07-2)-1. 13p. Dep. CFSTI.

An instrument was developed to monitor two locations for radioactivity. Each monitoring channel contains four plug-in circuit boards connected to form a count rate meter with a four-decade logarithmic readout. Scintillation detectors are used. (auth)

27345 (KFKI-70-4) CALCULATION CONCERNING THE CALIBRATION OF A WHOLE BODY COUNTER. Andrasi, A.; Feher, I.; Koetel, Gy. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1970]. 17p. Dep. CFSTI (U. S. Sales Only).

Calculations of the relative photopeak efficiencies of NaI(Tl) scintillation detectors using the tilting chair and scanning geometries with point sources are described. Measurements with a cesium-137 point source were performed and compared to the calculated results. (W.H.K.)

27346 (KFKI-70-7) CALCULATIONS CONCERNING THE CALIBRATION CHARACTERISTICS OF A WHOLE BODY COUNTER. Andrasi, A.; Koetel, Gy. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1970]. 20p. Dep. CFSTI (U. S. Sales Only).

A mathematical model was used to evaluate the photopeak efficiency for a point source to establish the most suitable geometry and the optimum operational parameters for a NaI(Tl) whole-body counter. The three geometries studied were tilting chair, arc, and scanning bed arrangements. (W.H.K.)

27347 (N-69-19670) BASIC RESEARCH IN SEMICONDUCTOR DETECTOR-DOSIMETER CHARACTERISTICS. Crawford, George W. (ed.) (Southern Methodist Univ., Dallas, Tex. Dept. of Physics). Aug 1968. 173p. (NASA-CR-100317; RR-68-1). CFSTI.

A detailed account of the theory and fabrication of lithium-drifted silicon detectors is presented, and theory and fabrication instructions are extended to apply to detectors of very large volume. The studies cover 70 different detectors ranging in size from 1 × 1 × 1 to 7 × 7 × 150 mm. Long detectors, i.e., detectors having proton path lengths of 10, 20, 30, 50, 70, 100, 120, 130, and 150 mm, were used for total absorption of high energy protons. The average energy required to produce an electron-hole pair in silicon was measured for each case. New techniques of fabrication, mounting, and encapsulation were developed to obtain specific configurations. Combinations of detectors were developed to permit simultaneous measurements of dE/dx and E, with identifi-

cation of both mass and energy of the incident particle. The charge collection characteristics of the detectors in a magnetic field were determined, including detector service life properties. The results of the research permit fabrication of detector configurations operating within a magnetic field which will produce the data required in the PROPER 3B Monte Carlo Transport Program to identify charge, mass, and energy of an unknown ionizing radiation of the meson, baryon, or heavier class. Detector charge responses were measured as a function of proton incident energy over the energy range from 8 to 186.6 MeV. (USGRDR)

27348 (N-70-15606) ^{14}C RADIATION DETECTION SYSTEM FOR LIFE DETECTION EXPERIMENTS. Clark, Benton C. (Avco Electronics Div., Tulsa, Okla.). Nov 1969. Contract NAS2-5547. 98p. (NASA-CR-73402). CFSTI.

A carbon-14 radiation detection system has been developed for use in a science breadboard experiment to demonstrate the feasibility of detecting life on Mars using the carbon dioxide tracer technique. The detection system consists of a spherical proportional counter to measure the beta rays from carbon-14. This counter is built inside a plastic scintillator. The purpose of the scintillator and anti-coincidence circuitry is to reduce sensitivity to background radiation, especially that produced by SNAP-19 units in radioisotope thermoelectric generators (RTG's). Methods of reducing the radiation interference from the RTG's are recommended in terms of location, orientation, shielding, and manufacturing procedures for the SNAP-19. Areas requiring further investigation include the study of a cesium iodide scintillator and a flight qualified photomultiplier tube, design of the system for withstanding all sterilization and mechanical stress environments, and development of countermeasures to the effects of water vapor and electronegative gases upon the operation of the system. (auth) (USGRDR)

27349 (N-70-21176) RADIATION SURVEY METER WITH COUNT RATE MODE. Final Report. (General Dynamics/Fort Worth, Tex.). 31 May 1968. Contract NAS9-6287. 88p. (NASA-CR-109142; FZK-358). CFSTI.

The Radiation Survey Meter (RSM), developed and fabricated for the Apollo program, measures the dose rate over four selectable ranges: 0 to 100 mRad/h, 0 to 1 Rad/h, 0 to 10 Rad/h, and 0 to 100 Rad/h; which are displayed on a linear meter readout. The RSM weighs 1.58 lb and has an overall length of 9.560 in. and maximum diameter of 2.324 in. The extension of the capability of the RSM to include a Count Rate Mode (CRM) for geological counting of soil/rock samples on the lunar surface is reported. The prototype RSM/CRM weighs 1.83 lb and has an overall length of 10.675 in. and a maximum diameter of 2.475 in. (auth) (USGRDR)

27350 (NBS-TN-489) TABLES OF RESPONSE FUNCTIONS FOR SILICON ELECTRON DETECTORS. Berger, M. J.; Seltzer, S. M.; Chappell, S. E.; Humphreys, J. C.; Motz, J. W. (National Bureau of Standards, Washington, D. C.). Aug 1969. 66p. GPO $0.60.

Calculated response functions are presented which describe the pulse-height distributions produced by monoenergetic electrons incident on silicon detectors. It is assumed that the direction of incidence is perpendicular, and that the detectors are wide enough so that lateral leakage of energy is insignificant. The validity of the calculations has been confirmed experimentally for incident energies between 0.25 and 1.0 MeV and detectors with thicknesses between 0.061 and 3.0 mm. The calculated response functions cover a wider range of conditions, including fourteen energies between 0.15 and 5.0 MeV and ten detector thicknesses between 0.05 and 10.0 mm. At energies ≥1 MeV, response functions are given not only for bare detectors but also for an arrangement in which the detectors are shielded on the transmission side by another detector operating in anticoincidence. (auth) (USGRDR)

27351 PHYSICS OF THE PHOTOGRAPHIC PROCESS. Slifkin, Lawrence (Univ. of North Carolina, Chapel Hill). pp 241-59 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

Topics include the electron band structure of silver bromide and chloride, formation of the latent image, electrons and holes, reciprocity failure and the latent image, latent image regression effects, sensitization, high energy radiation and particles, and properties of silver halide emulsions. (46 references) (W.H.K.)

27352 SEMICONDUCTOR JUNCTION DETECTORS AND THEIR APPLICATION TO RADIATION DOSIMETRY. Parker, R. P. (Inst. of Cancer Research, Surrey, Eng.). pp 375-92 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

Topics include physical principles of semiconductor detectors, types of semiconductor junction detectors, x-ray and gamma-ray dosimetry, charged particle dosimetry, and radiation damage in semiconductor detectors. (34 references) (W.H.K.)

27353 CHARGED PARTICLE TRACKS IN INSULATING SOLIDS. Mory, J. (CEN, Fontenay-aux-Roses, France). pp 393-443 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

The development of particle tracks in insulating materials by etching, track counting, and characteristics of insulating particle track detectors including environmental factors, particle track formation mechanism, and sensitivity are discussed. The development of insulating particle track detectors for neutron detection and dosimetry is reviewed. Boron glasses (n,α) are used for low-flux thermal neutron detection and fission foils (n,f) are used for high-flux thermal and fast neutron detection. The characteristics of various fission foils and insulating detectors are briefly reviewed. Other studies which utilize particle tracks in insulating materials are discussed including the study of fission and spallation, measurement of half-life of unstable elements, measurement of age of terrestrial and extra-terrestrial minerals, and metallurgical microanalysis. Also, the use of particle track detectors in solid state physics for studying the channeling effect including the effect of orientation and grain boundaries, stacking faults, dislocations, and the deformation band is described. (65 references) (W.H.K.)

27354 PARTICLE IDENTIFICATION BY DIELECTRIC TRACK DETECTORS. Price, P. B.; Fleischer, R. L. (General Electric Research and Development Center, Schenectady, N. Y.). Radiat. Eff.; 2: 291-8(Mar 1970).

Chemical reactivity along the trajectory of a charged particle in a dielectric solid depends on the density of radiation-damaged species. In inorganic crystals such as are found in meteorites, cosmic rays can be identified by etching for a long time and measuring the entire etchable ranges of the slowing particles, which are related to their atomic numbers. In plastics, the etching rate is an increasing function of radiation damage density. Measurements of etched "cone" lengths at different points along the trajectory of a particle that passes through several sheets provide a very sensitive measure of atomic number. In favorable cases it is possible even to resolve isotopes with the same atomic number. In addition to serving as a general review of work on particle identification using these two schemes, this report provides some unpublished experimental details that are useful in achieving high resolution and reports some new, unpublished measurements. (auth)

27355 DIELECTRIC PLASTICS AS HIGH EXPOSURE GAMMA-RAY DETECTORS. Frank, A. L.; Benton, E. V. (Univ. of San Francisco). Radiat. Eff.; 2: 269-72(Mar 1970).

Dielectric plastics are being developed as high exposure dosimeters. The principle of operation is based on the relationship between the absorbed dose and the increased chemical reactivity of these dielectric solids. Polycarbonate plastics can be utilized in measuring absorbed dose in the range of about 10^7–10^9 rads. The advantages of the technique lie in the low cost of the detectors, ease of data readout, and high degree of reproducibility achievable. It is hoped that the method can be extended to include the dosimetry of massive doses of soft, low penetrating power x- or γ-radiations. (auth)

27356 LATENT TRACK FORMATION IN ORGANIC NUCLEAR CHARGED PARTICLE TRACK DETECTORS. Benton, E. V. E. V. (Univ. of San Francisco). Radiat. Eff.; 2: 273-80(Mar 1970).

In recent years, in a number of laboratories throughout the world, a considerable amount of effort has gone into the development and the understanding of organic nuclear charged-particle track detectors. Even in their developmental stage, these detectors have found numerous applications in several scientific fields. A brief résumé is presented of some of the most important recent developments in this field. The scope is limited to the pre-etching phenomena; etching and post-etching treatments are covered by Medveczky. (auth)

27357 EFFECT OF WIRE-TO-PLATE SPACING ON THE CHARACTERISTICS OF ALPHA PARTICLE SPARK COUNTER. Abu-Zeid, Hosnia M.; Gad, E. A.; Abu-Zeid, Hamed M. (Ain Shams Univ., Cairo). J. Phys., E (London); 3: 385-7(May 1970).

Investigation of the single wire counter characteristics in dry air, free from carbon dioxide, was undertaken for different values of external quenching resistance, which corresponded to various values of electrode spacing. An empirical formula was derived which explains the contradictory results on the shape of the plateau found by different authors. (auth) (UK)

27358 WATER-SOLUBLE EPOXY CEMENT FOR SCINTILLATION COUNTERS. Permyakova, L. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp.; No. 6, 207 (Nov-Dec 1969). (In Russian).

A water-soluble epoxy cement using epoxy resin DEG-1 and ethylenediamine hardener was successfully used for obtaining an optical contact between the photomultiplier tube and the light block. The gravimetric ratio of resin to hardener was 10:1. (C.E.S.)

27359 SILICOORGANIC COMPOUNDS FOR OPTICAL CONTACTS. Antonov, R. P.; Zhinkin, D. Ya.; Korneeva, G. K.; Rodzevich, N. E.; Semenova, E. A.; Timoshina, V. N.; Uklonskii, D. A.; Chukin, V. S. Prib. Tekh. Eksp.; No. 6, 180-2 (Nov-Dec 1969). (In Russian).

The optical properties of several silicoorganic compounds that were used for optical contacts in optical systems, in particular, for connection of the detector to the photomultiplier tube in scintillation and Cherenkov detectors, are given. (tr-auth)

27360 LOW-NOISE TRANSISTOR PREAMPLIFIER FOR SEMICONDUCTOR DETECTORS. Kulakov, F. M. (Leningrad Polytechnic Inst.). Prib. Tekh. Eksp.; No. 6, 110-14(Nov-Dec 1969). (In Russian).

A method of calculating the operational regime of the preamplifier and filter parameters from the point of view of assuring minimum noise was proposed. The magnitudes of the minimum achievable noise in semiconductor detectors with preamplifiers using domestic transistors were determined. (tr-auth)

27361 OSCILLOGRAPHIC RECORDING OF THE SHAPE OF SHORT PULSES OF RADIATION. Aleksandrov, V. A.; Gorbachev, V. M.; Korolev, V. N.; Usenko, L. D. Prib. Tekh. Eksp.; No. 6, 100-3(Nov-Dec 1969). (In Russian).

The method and calculational results of the pulse characteristics of a measuring channel of equipment for oscillographing short pulses of radiation are given. The channel contains a scintillator, photomultiplier, cable, amplifier, and CRT. The width of the pulse was determined by successive passage of a δ-function pulse through the measuring channel. Calculated results are compared with the oscillogram of a single pulse of gamma radiation. (tr-auth)

27362 APPLICATION OF AI-256 FOR MULTIDIMENSIONAL ANALYSIS. Balamatov, N. N.; Goryachev, B. I. (Inst. of Nuclear Physics, Moscow). Prib. Tekh. Eksp.; No. 6, 69-72(Nov-Dec 1969). (In Russian).

Equipment constructed using AI-256 as a base is described, and results of an experiment on the separation of yields of (γ,n) and $(\gamma,2n)$ reactions on ^{165}Ho are given. (tr-auth)

27363 HIGHLY EFFICIENT NEUTRON DETECTOR. Ishkhanov, B. S.; Kapitonov, I. M.; Laxutin, E. V.; Piskarev, I. M.; Shevchenko, O. P. (Inst. of Nuclear Physics, Moscow). Prib. Tekh. Eksp.; No. 6, 59-61(Nov-Dec 1969). (In Russian).

A highly effective neutron detector with a weak relation of detection efficiency to the initial energy of the neutrons is described. The efficiency of the detector is ~45%. The detector was used to measure the photoneutron reaction cross sections for a series of isotopes. (tr-auth)

27364 HIGH-SPEED FISSION IONIZATION CHAMBER. Kononov, V. N.; Metlev, A. A.; Poletaev, E. D.; Prokopets, Yu. S. Prib. Tekh. Eksp.; No. 6, 51-5(Nov-Dec 1969). (In Russian).

A high-speed pulsed ionization chamber, which permits high-efficiency detection of fission fragments in the presence of a high alpha particle background, is described. The increase in high-speed operation was achieved as a result of using current pulses emerging in the chamber upon the detection of a charged particle and subsequent amplification and discrimination by means of pulse broad-band current apparatus. The chamber, which contains 75 mg ^{239}Pu (~1.7×10^4 α particles/sec), has an efficiency of ~75%. The small duration of the pulse front permits the use of the detector in experiments with nanosecond time resolution. (tr-auth)

27365 MULTILAYER IONIZATION CHAMBER WITH A CENTRAL COLLECTOR. Popov, Yu. P.; Stempinskii, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp.; No. 6, 49-51(Nov-Dec 1969). (In Russian).

A multilayer pulsed ionization chamber with the area of electrodes ~0.1 m^2 with a common central collector combining the geometry of a flat multilayer ionization chamber, the small electric capacity of the collector, and the amplitude resolution of a cylindrical chamber is described. (tr-auth)

27366 CONTAINER FOR COOLED SCINTILLATION CRYSTALS. Adamovich, N. I.; Vorob'ev, Yu. A.; Zuev, V. I.; Pavlovskaya, T. F. Prib. Tekh. Eksp.; No. 6, 48-9(Nov-Dec 1969). (In Russian).

The construction of a container for packing scintillation monocrystals for operation in the temperature range +25 to −150°C was described. The container provides vacuum packing and reliability of the optical contact between the crystal and the optical window of the container. (tr-auth)

27367 AGING OF PLASTIC SCINTILLATORS WITH A POLYSTYRENE BASE. Zhil'tsova, L. Ya.; Matveeva, E. N.; Medvedev, M. N.; Rubina, O. G.; Stoletova, I. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp.; No. 6, 45-8(Nov-Dec 1969). (In Russian).

Experimental data concerning changes of scintillation characteristics of plastic scintillators with a polystyrene base over the 12 yr period of storage are given. Causes effecting such changes in the plastic scintillators were established. (tr-auth)

27368 CONTINUOUS AIR MONITOR DETECTOR PROBE (23 Jan 1967) (Engineering Materials). (Argonne National Lab., Ill.). (CAPE-1993).

16 drawings.

Two stacked gas-proportional counters are employed in a system for immediate and simultaneous detection of long half-life radioactive-airborne particulates collected on a large fixed filter media. The α and $\beta-\gamma$ counting rates and the nullification or differentiation of these counting rates are indicated separately on linear count-rate meters and strip-chart recorders. The two proportional detectors, which are of the flat-plate type, are mounted one above the other. The window of the α chamber allows α and β particles to enter, but with an applied voltage of 1000 to 1200 V, only the α particles are counted. The β particles pass through the α chamber to the upper chamber where a central wire voltage of 1500 to 1750 V produces response to β activity. Absorption afforded by the window is sufficient to reduce α penetration. A two-stage regulator maintains a positive atmosphere within the detectors. A needle valve is adjusted so that gas will flow through a bubble-type flow meter at a rate of 1 bubble/sec. A size 2 gas cylinder lasts for about 2400 hr of continuous operation. (For details see TID-4100 Suppl 58) (See also 19: 3832) (F.S.)

27369 n-p JUNCTION PHOTODETECTORS IN InSb FABRICATED BY PROTON BOMBARDMENT. Foyt, A. G.; Lindley, W. T.; Donnelly, J. P. (Massachusetts Inst. of Tech., Lexington). Appl. Phys. Lett.; 16: 335-7(1 May 1970).

n-p Junction photovoltaic detectors were fabricated in InSb using proton bombardment to create the n-type layer. At 77°K, diodes which were 20 mils in diameter had zero-bias resistances of several hundred thousand ohms. The peak detectivity at 4.9 μ of these diodes with a 2π, 300°K background was typically greater than 3×10^{10}cm $Hz^{\frac{1}{2}}$/W with the largest value observed being 10^{11} cm $Hz^{\frac{1}{2}}$/W. Diode quantum efficiencies near 35% were observed. (auth)

27370 TECHNICAL PROBLEMS IN THE APPLICATIONS OF Ge(Li) GAMMA-RAY DETECTORS. Gossett, Charles R. (Naval Research Lab., Washington, D. C.). pp 1-16 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

The factors which affect the principal characteristics of resolution, efficiency, counting rate, and timing capabilities for each of the major elements of the single detector system including the detector itself, the preamplifier, shaping amplifier, optional post-amplification electronics including timing circuitry, and the analog-to-digital converter are discussed. (W.H.K.)

27371 ENHANCING RADIATION DAMAGE FOR NUCLEAR PARTICLE DETECTION. Sherwood, Harold Frank (to Eastman Kodak Co.). U. S. Patent 3,501,636. 17 Mar 1970. Filed 9 Nov 1966.

A solid-state nuclear particle detector is composed of two layers, an overcoat sensitive to radiation damage and an underlying material in which color changes occur when contacted by certain materials. The radiation-damageable material is exposed to the nuclear particles and then etched to produce fine channel in the material showing the particle paths. A modifier is then applied to the overcoat and passes through the etched paths in the overcoat to react with the color sensitive material in the underlying material. This provides a high-contrast image of the radiation damage caused by the particles. Various materials are suggested for both the overcoat and underlying material depending on

the type radiation to be detected, and the type of indication of radiation damage desired. (B.L.M.)

27372 RATIO CIRCUIT FOR POSITION SENSITIVE DETECTORS. Nakamoto, Shunsuke. Chubu Kogyo Daigaku Kyo; 5: 173-8(Dec 1969). (In Japanese).

Recircuitry position sensitive (triode) detectors were fabricated for particle position measurements in nuclear reactions or in magnetic analyses. From these detectors the signal of the incident particle can be detected as ordinary semiconductor detectors, but the signal related to the position of the incident particle also can be detected. The former signal is called the energy signal (E) and the latter the position signal (XE). If the position signal can be divided by the energy signal, we can know the position of the incident particle (X). For this dividing method, a ratio circuit is fabricated. This circuit makes use of the sampling technique. The input voltage from the energy signal is allowed from 1 to 5 V. The linearity of the ratio output is better than 1% for a constant energy signal voltage, and is better than 4% for the allowed energy signal voltage. This circuit is tested by a dirty Po-α source and a surface barrier type position sensitive detector. This test shows the usefulness of the circuit. (auth)

27373 RECTIFYING PROPERTIES OF SURFACE BARRIER DETECTORS. Aoki, Takashi. Chubu Kogyo Daigaku Kyo; 5: 179-84(Dec 1969).

A number of surface barrier nuclear particle detectors were fabricated and tested. After aging thirty days in air, the resolution of the detector yielded 0.5% for ^{241}Am (5.477 MeV) alpha particles and the noise level was very low. The effects of ambient conditions and continuous electric fields on the rectification characteristics of the detector are described. Nitrogen gas increased the reverse current of the detector remarkably. The continuous electric fields in the inverse direction decreased the reverse current, which remained almost unchanged after about 60 minutes. Whether the continuous electric field shortens an interval of aging, that is needed to accomplish a good detector, or not is left for a future study, because the detector deteriorates again while free from the electric field. (auth)

27374 REFLECTIVE COVERINGS FOR SCINTILLATION COUNTERS. Kilvington, A. I.; Baker, C. A.; Illinesi, P. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods; 80: 177-8(1970).

The effect upon the light collection efficiency of various reflective coverings on light guides used with scintillation counters is investigated. (auth)

27375 Ge(Li) WELL-TYPE DETECTOR FOR MEASURING LOW γ ACTIVITIES. Glasow, P. (Siemens-Schuckertwerke AG, Erlangen, Ger.). Nucl. Instrum. Methods; 80: 141-5(1970) (In German).

When making measurements with Ge(Li) well-type detectors it was found that contrary to expectations the pulse rate increased by more than the factor of 2 when changing from a 2π geometry to a nearly 4π geometry in the well. γ-rays backscattered during Compton processes are also detected and increase the efficiency. This also contributes to an improvement of the peak to Compton ratio. Another advantage is that sumpeaks are also detected in sources with cascade transitions. For these reasons Ge(Li) well-type detectors are a promising development for measuring low γ-activities in radiochemistry and in other fields. (auth)

27376 SPECTRUM OF A SMALL ROD-SHAPED Si-DETECTOR FOR MEDICAL APPLICATIONS. Glasow, P.; Jaentsch, O. (Siemens-Schuckertwerke AG, Erlangen, Ger.). Nucl. Instrum. Methods; 80: 146-8(1970).

Diffused Si-detectors for medical applications have a continuous spectrum decreasing with increasing channel number. This is also true for monoenergetic particles. It can be explained quantitatively by a RC delay line caused by the capacitance of the space charge layer and the resistance of the core. (auth)

27377 GAS CHERENKOV DETECTOR FOR LOW ENERGY GAMMA RAY ASTRONOMY. Helmken, H. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Contract F19268-68-C-0297. Nucl. Instrum. Methods; 80: 125-8(1970).

The gas Cherenkov balloon-borne cosmic gamma ray detector described has a variable energy threshold and is sensitive down to 15 MeV with a half-angle resolution of 5° to 7°. Gamma rays are detected by a coincidence between light pulses from a scintillator plate, where the gamma rays convert and Compton-scatter, and a mirror that collects the Cherenkov radiation emitted as the gamma ray-produced electrons move through a 2 m gas column between the scintillator plate and the mirror. The detector's efficiency and angular response were calculated by a Monte Carlo program and used to predict minimum detectable source intensities. (auth)

27378 CONSTRUCTION OF A PRESSURE-RESISTANT FLOW CELL OF HIGH EFFICIENCY FOR SCINTILLATION COUNTING WITH ACCELERATED AMINO ACID ANALYSIS. White, Frederick H. Jr.; Mencken, Calvin R. (National Inst. of Health, Bethesda, Md.). Anal. Biochem.; 34: 560-7(Apr 1970).

The construction of a plastic cell for scintillation flow counting is described, the efficiency of which is higher than those of several other cells examined. This result is due in part to the flattened design of the fluor-containing chamber, permitting a relatively large number of scintillations to be detected by the phototubes. A salient feature of this cell is its resistance to leakage at high pressures, made possible by the use of a seamless plastic cylinder as an external casing. The cell has been adapted to an accelerated system of amino acid analysis. (auth)

27379 SOME DEVELOPMENTS IN THE OPERATION OF MULTIWIRE PROPORTIONAL CHAMBERS. Charpak, G.; Rahm, D.; Steiner, H. (CERN, Geneva). Nucl. Instrum. Methods; 80: 13-34(1970).

A discussion of the limits of proportional amplification in multiwire proportional chambers is presented. Chambers with 2 mm wire spacing can give pulses of more than 200 mV on 20 pF loads with 25 nsec maximum time jitter. Some examples of operation beyond the proportional region are given. Multigrid chambers permit an increased gain for smaller wire separation and have multiple applications. Better time and space resolution can be obtained from the time-position correlation. Resolutions of 7 nsec (fwhm) and 0.2 mm (fwhm) have been observed. The use of the positive induced pulse permits the two-dimensional readout from single gaps. The effects of magnetic fields up to 45 kG have been measured. Some new lines of research are discussed. (auth)

27380 METHOD FOR MEASURING INTRINSIC REGION THICKNESSES OF SOLID STATE DETECTORS. Hubbard, E. L.; Peterson, D. G. (Philco-Ford Corp., Palo Alto, Calif.). Nucl. Instrum. Methods; 80: 40-4(1970).

A method is described for measuring the effective thickness of the intrinsic region of solid state detectors to an accuracy of ≈2%. This method employs the proton beam of an accelerator, in this case the University of Southern California Linac and the University of Colorado Cyclotron. This method can also be used to measure the effective nuclear thickness of materials that might be used in charged particle detector telescopes, especially those that use range measurement as a method of particle discrimination. Results of the measurements are given. (auth)

27381 EFFECT OF CONTACT POTENTIAL DIFFERENCE IN IONIZATION CHAMBERS. Nakatani, Tadashi; Inabe, Katsuyuki (Kanazawa Univ., Japan). Kanazawa Daigaku Kogakubu Kiyo; 5: 325-32(Feb 1970).

A small current is observed in an ionization chamber irradiated by x-rays without the application of voltage. Experimental investigations are made in order to clarify the mechanism of this current with x-rays of 140 to 180 kV. The experiments are made under the following conditions: (1) insertion of high resistor in the measuring circuit, and (2) application of low voltage to chambers with electrodes of various materials. The current is mainly generated by the contact potential difference between electrodes, and effects of Compton current and of polarization in dielectrics are neglible. The contact potential differences of the order of 10^{-2} V are observed between graphite electrodes. (auth) (NSA of Japan)

Nuclear Spectroscopic Instrumentation

27382 (CEA-R-3981) CONSTRUCTION OF A MULTIPARAMETER ANALYZER WITH TIME-OF-FLIGHT SPECTROMETRY FOR FAST NEUTRONS AND GERMANIUM SPECTROMETRY FOR 0.2 TO 15-MeV PHOTONS. APPLICATION TO THE REACTIONS (n,γ) AND (n,n'γ). Sonrel, Claude (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr 1970. 84p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Grenoble, France.

The excellent energy resolution which can be obtained with a germanium crystal makes it of great interest for the study of γ radiation produced by capture and inelastic scattering of 14 MeV neutrons. A study has been made, as a function of the volume (up to 120 cm^3) of these Ge(Li) detectors, of the problems arising for the attainment of good time resolution (≈2 nsec) and the detection of 0.2 to 20 MeV photons (resolution, efficiency). This spectrometer has been coupled to the fast neutron time-of-flight spectrometer (≤14 MeV). The multiparameter analyzer is directly linked to an IBM 360/50 computer through a liaison network. This equipment has been built with a view to studying (n,n'γ) reactions on ^{7}Li, ^{12}C and ^{16}O. (France)

27383 (HASL-225) COMPUTATIONAL METHOD FOR PHOTOPEAK LOCATION AND INTEGRATION. Graveson, R. T. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Apr 1970. 43p. Dep. CFSTI.

The statistical broadening of a total energy absorption peak in pulse height spectroscopy complicates the identification of the mean pulse height and the assessment of the total counts included within the peak. A set of sequential computations has been developed to reduce observed spectral peaks to their basic parameters of location, width, and total area. The first equations are used to obtain the charge calibration of the electronic system. Background is subtracted from the spectral peak by an exponential estimate of the continuum. The location of the corrected peak is determined by the fitting of a parabola to the observed data. The statistical width is derived from a normalized Gaussian fit. The results of these computations are used to calculate the peak parameters. The equations have been programmed for the Olivetti Programma 101 calculator, and are included in the Appendix. (auth)

27384 (IJS-570) SET OF SEVEN THRESHOLD DETECTORS USED AS A FAST NEUTRON SPECTROMETER. Najzer, M.; Rant, J.; Solinc, H. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Oct 1969. 22p. Dep. CFSTI (U. S. Sales Only).

Seven threshold detectors, $^{115}In(n,n)^{115m}In$, $^{64}Zn(n,p)^{64}Cu$, $^{27}Al(n,p)^{27}Mg$, $^{56}Fe(n,p)^{56}Mn$, $^{24}Mg(n,p)^{24}Na$, $^{27}Al(n,a)^{24}Na$ and $^{19}F(n,2n)^{18}F$ have been selected for measurements of neutron spectra in the energy interval from 1.5 to 14 MeV. Characteristic features concerning the activation in the neutron flux, measurements of induced activities, and determination of specific activity are described for each selected detector. (auth)

27385 (LA-4243-TR) IMPROVING GRID IONIZATION CHAMBER CHARACTERISTICS FOR ALPHA SPECTROMETRY. Le Du, Rene; Miltenberger, Bernard (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Translated for Los Alamos Scientific Lab., N. Mex., from report CEA-R-3566. 12p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 6303.

27386 (LA-4326) COMPUTER CODES FOR PRESENTATION, INTERPOLATION, AND INTEGRATION OF TWO-PARAMETER DATA. Barnes, Barry K.; Sanders, W. Mort (Los Alamos Scientific Lab., N. Mex.). 3 Apr 1970. Contract W-7405-eng-36. 25p. Dep. CFSTI.

Three computer codes and their associated subroutines are described for the handling and presentation of data taken as a function of two coordinates. Interpolatory cubic spline functions are used to interpolate irregularly spaced data points to obtain regularly spaced data. Spline functions are also used to integrate the volume under the surface formed by the data. Presentation of the data is made either as an isometric projection plot or as a density plot. These two forms of presentation are compared with each other and with contour plots. (auth)

27387 (RCN-116) ANDANTE: AN ALGOL PROGRAM FOR DECOMPOSITION OF GAMMA-RAY SPECTRA AND PROCESSING OF FOIL COUNTING DATA. Struch, H. P. (Reactor Centrum Nederland, Petten). Dec 1969. 128p. Dep. CFSTI (U. S. Sales Only).

ANDANTE is an ALGOL 60 program for the analysis of foil counting data obtained in neutron activation. The gamma-ray spectra are measured with the aid of NaI(Tl) scintillation crystals and counted with multichannel analyzers. The program provides relative counting rates, activity, flux, and fluence values. In addition, ANDANTE is rather well suited to decompose a complex spectrum into its known constituent spectra. Provisions are included to reject constituents which during the calculation appear to be non-significant. The program can be run in 63 various modes. This allows the user to apply ANDANTE in many different ways. (auth)

27388 DETECTABILITY OF IMPURITIES IN PURE β-EMITTERS BY MEANS OF SCINTILLATION SPECTROMETER. Kempisty, Tadeush; Lada, Vitold (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 14: 967-93(Oct 1969). (In Russian).

The determination of the lowest limit of detectability of impurities in β emitters using a β scintillation spectrometer and the least squares method has been investigated. An anthracene crystal β scintillation spectrometer was used for the measurements, and the radioisotope mixtures such as $^{32}P + {}^{35}S$, $^{32}P + {}^{45}Ca$, $^{32}P + {}^{147}Pr$ and $^{32}P + {}^{91}Y$ were applied. The measurements have allowed to determine the lower limit of detectability, and shown that the sensitivity of the method depends on the ratio of the maximum energy of β particles of impurity to that of β particles of the basic radioisotope. (auth)

27389 SEPARATING OUT DISTORTED SIGNALS IN AMPLITUDE SPECTROMETRY. Ivanov, V. B.; Shimanskii, A. M.; Shiptlov, V. I. (Scientific-Research Inst. of Atomic Reactors, Melekess, USSR). Prib. Tekh. Eksp.; No. 6, 5-13(Nov-Dec 1969). (In Russian).

In nuclear spectrometry with high resolution signal measurements, deformations of amplitudes of separate pulses are inevitable because of superpositions of the high-frequency pulses. Therefore provisions must be made for the removal of distorted signals. Descriptions of plans for separating out these distorted signals are widely dispersed in the journal literature. This review attempts to classify and discuss the main parameters and applications of the various existing plans. (tr-auth)

27390 EQUIPMENT FOR MEASURING THE FISSION PARAMETERS OF NUCLEI FOR NEUTRONS WITH ENERGIES OF 0.7 TO 7 MeV. Savin, M. V.; Khokhlov, Yu. A.; Il'in, Yu. I.; Shein, Yu. V. Prib. Tekh. Eksp.; No. 6, 27-30(Nov-Dec 1969). (In Russian).

The methodology of measurement of the fission parameters σ_f, $\bar{\nu}$, $P(\nu)$ with a liquid scintillation detector and an electron linear accelerator with neutron energies of 0.7 to 7 MeV is discussed. The time-of-flight method with resolution of 1 nsec/m was used. (tr-auth)

27391 A COINCIDENCE-ANTICOINCIDENCE Ge(Li)-NaI(Tl) SYSTEM. Van Patter, D. M. (Franklin Inst., Swarthmore, Pa.). pp 99-108 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

A coincidence-anticoincidence lithium-drifted germanium-thallium-activated sodium iodide detector system for use as a pair spectrometer is described. (W.H.K.)

27392 USES OF MAGNETIC SPECTROMETERS. Young, F. C. (Univ. of Maryland, College Park). pp 109-29 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

The advantages of a magnetic spectrometer combined with a solid-state detector are discussed, and the use of such a system for studying ion products from nuclear reactions is considered. Also, the use of magnetic spectrometers for measuring peak-to-total ratios and efficiencies of gamma detectors is described, and use for charged particle-gamma angular correlation measurements is discussed. (W.H.K.)

27393 (p,n) AND (d,n) TIME-OF-FLIGHT EXPERIMENTS. Stelson, P. H. (Oak Ridge National Lab., Tenn.). pp 141-65 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

Nanosecond beam pulsing techniques and precise time-of-flight methods for studying nuclear reactions in which fast neutrons are emitted are reviewed. Some results for (p,n) and (d,n) reactions on carbon-13, copper-65, cobalt-59, yttrium-89, tin-119, and nickel-58 are given. (W.H.K.)

27394 GAMMA RAYS FROM NEUTRON INELASTIC SCATTERING. McEllistrem, M. T. (Univ. of Kentucky, Lexington). pp 167-94 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

Measurements made on prompt gamma rays following neutron inelastic scattering and the information extracted from the measurements are reviewed. Techniques used to measure differential production cross sections and gamma-ray energies are discussed. Ring detection geometry and shielded anti-Compton spectrometers using NaI(Tl) and Ge(Li) detectors are described. (W.H.K.)

27395 TIME-OF-FLIGHT SPECTROMETER FOR MEASUREMENT OF SCATTERING NEUTRON CROSS-SECTIONS. Gerasimov, V. F.; Zenkevich, V. S.; Moskalev, S. S. At. Energ. (USSR); 28: 120-5(Feb 1970). (In Russian).

A time-of-flight spectrometer for measuring neutron scattering cross sections in a linac is described. A sample is positioned near the neutron source. Li-6 glass scintillators are used as neutron detectors. The time resolution is 22 nsec/m for neutron energies ≥500 eV. (auth)

27396 A SPECIAL COUNTER FOR CHROMATOGRAPHIC AND ELECTROPHORETIC BANDS OF ^{125}I. Espinasse, P.

(Faculte de Medecine et de Pharmacie, Lyon). J. Biol. Med. Nucl.; 3: No. 13, 25-7(1968). (In French).

Half life of two months and emission characteristics provide ^{125}I with biologically interesting properties. But measurements of emission are limited to 30 keV photons that are obtained in good yield, when a special collimator and detector are used. The measurement apparatus consists of 2 face to face arranged Plexiglas cylinders which are cut laterally in the middle where a 2 mm thick plate of NaI(Tl) crystal is inserted. The faces are covered with 0.2 mm thick Be windows which are 3 mm apart. This distance allows the insertion of 2 Cu collimators of 1.2 mm thickness between which a 0.6 mm slit provides adequate space for the insertion of the chromatographic paper. Each detector is provided with a single channel amplifier and a high voltage photomultiplier. The channel width ranges from 18.5 to 39.5 keV so that the principal peak is in the center. Standardization is carried out with 9 and 25 mm long threads, impregnated with ^{125}I solution and placed on Whatman filter paper, which give yields of 37.2 and 35.6% respectively. Although the above described detector assembly has only a limited applicability, its principle could be used for detectors for β-emitting ^{45}Ca, ^{42}K, and ^{24}Na as well as γ-emitting ^{197}Hg. (F.J.W.)

27397 SHIFT AND BROADENING OF MOESSBAUER PEAKS BY LACK OF COLLIMATION. Aramu, F.; Maxia, V. (Univ., Cagliari, Italy). Nucl. Instrum. Methods; 80: 35-9(1970).

The effect of γ-ray collimation geometry in measuring Mössbauer absorption spectra is studied quantitatively. It is found that the spectra undergo an expansion around zero velocity and the more the collimator allows high flows of γ-rays, the more important is the expansion. Equations are proposed to correct this effect. (auth)

27398 MULTIPLE LINEAR REGRESSION ANALYSIS OF SCINTILLATION GAMMA-RAY SPECTRA: THEORETICAL AND PRACTICAL CONSIDERATIONS. Covell, D. F.; Brown, M.; Yamamoto, S. (Naval Radiological Defense Lab., San Francisco). Nucl. Instrum. Methods; 80: 55-60(1970).

Application of the method of multiple linear regression (MLR) as a data-analysis technique for gamma-ray scintillation spectrometer data requires knowledge of (1) the response matrix of the spectrometer and (2) the covariance matrix of the unknown spectrum (or spectra). Neither matrix is known exactly. The response matrix can usually be determined with good precision and an estimate of the covariance matrix can usually be made. Perturbation or errors in either matrix, however, will introduce biases in the results. In addition, in the formulation of the method, assumptions are made and criteria are specified which may be appropriate for particular applications. Once generated, the particular formulation is frequently assumed to be generally applicable; additional biases can thereby be introduced. In this report, theoretical and practical considerations are delineated which are important to the satisfactory utilization of the MLR method. Subjective judgments which are introduced in the formulation of the method are indicated, and in view of these judgments, specific areas are described where care must be exercised, both in the acquisition of the data and in the subsequent processing. (auth)

27399 MULTIPLE LINEAR REGRESSION ANALYSIS OF SCINTILLATION GAMMA-RAY SPECTRA: AUTOMATIC CANDIDATE SELECTION. Hogan, M. A.; Yamamoto, S.; Covel, D. F. (Naval Radiological Defense Lab., San Francisco). Nucl. Instrum. Methods; 80: 61-8(1970).

Multiple linear regression (MLR) has been shown to be a quantitative and statistically justifiable method for unfolding scintillation gamma-ray pulse-height spectra of radionuclide mixtures. The principal requirements of the method are: (1) that well-calibrated data be used, and (2) that the candidate set of spectra (standard spectra to be used as regression variables) must be complete and exclusive. In the usual application of the MLR method, the user exercises a great deal of subjective (irreproducible) judgment in the selection of a candidate set. Several algorithms have been proposed for automatic candidate selection but are not completely justifiable on the basis of proper statistical procedures. In this report, an algorithm is described in which justifiable statistical procedures are used. Correlation coefficients are examined to determine the proper candidate set for a given experimental spectrum. The inclusion or exclusion of candidate spectra are justified on the basis of valid statistical indicators, and an estimate of the goodness of the final fit is provided. The results of unfolding actual experimental spectra by this method are included. (auth)

27400 STATISTICAL CHOPPER FOR NEUTRON TIME-OF-FLIGHT SPECTROSCOPY. Von Jan, R.; Scherm, R. (Institut Max von Laue-Paul Longevin, Grenoble, France). Nucl. Instrum. Methods; 80: 69-76(1970).

The method of pseudostatistical pulsing as applied to neutron time-of-flight measurements is analyzed to search for possible improvements. It is possible to obtain directly the shape of the time-of-flight spectrum as it would have been obtained with a single-pulse measurement without broadening due to the evaluation method and with statistical fluctuations which have virtually no correlations from one point to another. This is obtained by a modified evaluation method which does the crosscorrelation with a sequence of δ-functions instead of the full shape of the pseudostatistical pulse sequence. Each δ-function stands for one pulse which must be identical and which must give a "plateau" if several pulses follow in unit time intervals. Further we show that the usual way of using 50% "open time" in pseudostatistical pulsing leads in many cases not to an optimum statistical error. For many applications a duty cycle of 10 or 20% is slightly preferable. (auth)

27401 FACILITY FOR PHOTONEUTRON ANGULAR DISTRIBUTION MEASUREMENTS WITH HIGH NEUTRON ENERGY RESOLUTION. Hewitt, J. S.; McNeil, K. G.; Jury, J. W. (Univ. of Toronto). Nucl. Instrum. Methods; 80: 77-88(1970).

To further the understanding of giant resonance excitations in light nuclei, a facility for experimentally determining angular distribution coefficients as a function of photoneutron energy has been constructed in the University of Toronto Linac Laboratory. A single high resolution (0.2 ns/m) time-of-flight spectrometer is used and the experimental angle is changed by adjusting the direction of the bremsstrahlung beam. The auxiliary detectors and monitors necessary in applying this method are described in detail. The results of performance tests are presented along with an example of final data taken from the study of the $^{16}O(\gamma,n_0)^{15}O$ reaction with 31 MeV bremsstrahlung. (auth)

27402 COMPUTER PROGRAM FOR CALCULATION OF DECOUPLING CURVES. Falk, F.; Linnfors, A.; Orre, B.; Thun, J. E. (Uppsala Univ.). Nucl. Instrum. Methods; 80: 129-33 (1970).

Angular correlations perturbed by the combined static hyperfine and external magnetic interaction have been treated by a newly developed computer program. This case may be of interest in connection with alpha-decay and Coulomb excitation measurements. The program is described and some typical results are presented. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 27359 and 28477.

27403 (JINR-P13-5016) NEW METHOD OF THE INFORMATION EXTRACTION FROM SPARK CHAMBERS. Karzhavin, Yu. A.; Matyushin, A. T.; Matyushin, V. T.; Khachaturyan, M. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 12p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The results of preliminary experiments on investigation of a new method of the information extraction from spark chambers with solid electrodes are presented. The signals excited by a spark in the chamber electrodes are recorded by a piezoelectric element. Possibilities of designing a spherical chamber are discussed. The volume of the electronic equipment on-line with a computer is estimated. Realization of the method and the chamber would allow creation of a highly efficient "high-transmission" device with the target being situated inside the chamber for charged particle and γ-quanta recording. (auth)

27404 (LNF-69/67) HIGH SENSITIVITY DOUBLE ON LINE QUANTAMETER FOR BUBBLE CHAMBER EXPERIMENTS. Note No. 456. Coli, M.; Stella, B. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 31 Oct 1969. 12p. Dep. CFSTI (U. S. Sales Only).

One on line quantameter for low intensity γ rays beam operation is described having two measuring channels for internal control; one for counting of the γ quanta of the beam and the other for the integral measurement of the beam intensity. The detector was a lead converter followed by a plastic scintillator. The results are digitally displaced on the chamber pictures. Efforts were made to achieve stability of the system against aging and ambient temperature. (auth)

27405 (LUSY-6904) AN ANALYSIS OF STOPPING PARTICLES IN A BUBBLE CHAMBER. PART I. von Dardel, G.; Malmenaryd, G. (Lund Univ. (Sweden). Dept. of Physics). Nov 1969. 66p. Dep. CFSTI (U. S. Sales Only).

A computer program, GUIDE, for analyzing stopping particle tracks in a magnetic field in a liquid hydrogen bubble chamber is presented. A general test of the program is presented in the form of the calculation of the mass of a K^+ stopping particle. Figures and the program listing are presented in LUSY-6905. (W.H.K.)

27406 (LUSY-6905) AN ANALYSIS OF STOPPING PARTICLES IN A BUBBLE CHAMBER. PART II. von Dardel, G.; Malmenryd, G. (Lund Univ. (Sweden). Dept. of Physics). Nov 1969. 40p. Dep. CFSTI (U. S. Sales Only).

Figures and the program listing for GUIDE for analyzing stopping particle tracks in a magnetic field in a liquid hydrogen bubble chamber are presented. Development of the program is described in LUSY-6904. (W.H.K.)

27407 (N-70-23260) LARGE AREA HIGH RESOLUTION COSMIC RAY CHARGE COMPOSITION DETECTOR. Ormes, J. F.; Balasubrahmanyan, V. K.; Price, R. D.; Ryan, M. J.; Silverberg, R. F. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Mar 1970. 24p. (NASA-TM-X-63863; X-661-70-106). CFSTI.

A detector designed to study the charge composition of the primary cosmic radiation in the range Z = 3 to 30 has been flown on balloons during 1969. The flight is part of a program to study the charge composition in the energy range 10 to 100,000 GeV. The telescope consists of a four fold charge measurement using two plastic scintillators, a Cherenkoy detector and a mosaic CsI(Na) detector. The intrinsic limitations on charge resolution due to statistical fluctuations in energy loss are approached by correcting the pulse heights for geometrical effects. This is accomplished by calibrating the detector response in flight using a spark chamber to determine the particle trajectories. (auth) (USGRDR)

27408 (PPAR-25) CALIBRATION OF A LARGE NEUTRON COUNTER USING THE PION NUCLEON CHARGE EXCHANGE REACTION. Chen, K. W.; Crean, P. A.; Dakin, J. T.; Hauser, M. G. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). 7 Apr 1970. Contract AT(30-1)-2137. 28p. Dep. CFSTI.

The efficiency of several large liquid scintillation counters for detection of 110 MeV neutrons has been measured in a tagged neutron beam utilizing the reaction $\pi^- + p \rightarrow n + \pi^0$. These measured values have been combined with calculations based on known n + p and n + C scattering cross sections to obtain the neutron detection efficiency of these counters from 40 to 400 MeV. (auth)

27409 (SJC-T-69-3) WIDE-SCREEN TYPE MEASURING PROJECTOR. Kitagaki, T.; Tanaka, S.; Sato, T.; Ichimura, H.; Kichimi, H.; Kato, K. (Tokyo Univ. (Japan). Inst. for Nuclear Study). Dec 1969. 31p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

Following the MP-1, the MP-2 described here has been developed. Similarly to its predecessor, the MP-2 utilizes a film plane digitizing system for the digitization in particle track measurement. The MP is a bubble-chamber measuring projector. A film adsorbed on the film station is projected onto the screen. The film station is moved in the X- and Y-direction; and the coordinate, after adjusting the measuring point to the cross hair line, is read out as the movement of the film station. The points of improvement in the MP-2 are increased automatization, enlargement, and rapid operation. Construction and mechanism of the MP-2 are described. Various check measurements and the results of measurements of events are presented. (NSA of Japan)

27410 WEDGE-SHAPED DETECTOR FOR MEASUREMENT OF POSITION AND PROFILE OF A PARTICLE BEAM. Donskov, S. V.; Prokoshkin, Yu. D.; Shuvalov, R. S. (Inst. of High Energy Physics, Serpukhov, USSR). Prib. Tekh. Eksp.; No. 6, 18-21 (Nov-Dec 1969). (In Russian).

The characteristics of a detector with a wedge-shaped scintillator intended for the measurement of position and the profile of a beam of secondary particles of high energy from the 70-GeV proton synchrotron were described. The accuracy of determination of the center of the beam was ±1 mm and the space resolution of the detector was 10 mm. (tr-auth)

27411 APPLICATION OF THE INTEGRATED CIRCUIT P2113 FOR CONTROL OF THE HPD MEASURING TABLE. Yakovlevs, T. G.; Popov, M. I.; Ivanov, A. A. Prib. Tekh. Eksp.; No. 6, 74-7(Nov-Dec 1969). (In Russian).

The logical part of the control system for the HPD measuring table, the main elements of which are the domestic integrated circuits of type P2113, is described. The structure of the logical part and peculiarities of application of integrated circuits of this type are examined. Test results of a model of the apparatus are given. (tr-auth)

27412 SIMULATION OF A CHARGED PARTICLE TRACK IN A SPARK CHAMBER. Agan'yants, A. O. (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp.; No. 6, 43-4(Nov-Dec 1969). (In Russian).

A method for simulating the track of a charged particle by the irradiation of the working gas of the spark chamber with a narrow beam of photons is described. (tr-auth)

27413 USE OF CALIBRATED MARKS ON SPARK CHAMBERS. Bekker, B. I.; Belyakov, E. S. (Inst. of Physics, Erevan). Prib. Tekh. Eksp.; No. 6, 42-3(Nov-Dec 1969). (In Russian).

The method of application of reference marks on spark chambers using Scotchlite tape is proposed. The method is characterized by simplicity and convenience especially for photography of a large number of chambers. (tr-auth)

27414 FILMLESS OPTICAL METHOD OF RAPID REMOVAL OF INFORMATION FROM SPARK CHAMBERS. Alekseev, N. V.; Meshchanin, A. P.; Nurushev, S. B.; Chuntonov, G. A.; Yablokov, A. P. Prib. Tekh. Eksp.; No. 6, 40-2(Nov-Dec 1969). (In Russian).

A filmless optical method of removing information from a spark chamber is described. The coordinates of a spark are in the form of a binary combination of electric signals from a small-size photomultiplier. The accuracy of determination of the coordinates in this apparatus is ±0.5 mm with high speed operation of ≈10 MHz. (tr-auth)

27415 USE OF SPARK CHAMBERS FOR INVESTIGATING THE CHARACTERISTICS OF CHARGED PARTICLE BEAMS. Aref'ev, A. V.; Bayukov, Yu. D.; Zaitsev, Yu. M.; Kuleshova, L. N.; Leksin, G. A. (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp.; No. 6, 37-9(Nov-Dec 1969). (In Russian).

The possibilities of using multi-electrode spark chambers for the accurate determination of the momentum spectra and the composition of a particle beam are discussed. (tr-auth)

27416 LARGE SCANNING TABLE FOR ANALYSIS OF BUBBLE CHAMBER PHOTOGRAPHS. Almazov, V. Ya.; Burov, A. S.; Goryainov, A. A.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp.; No. 6, 36-7(Nov-Dec 1969). (In Russian).

The scanning table developed for analyzing photographs from the 2-m hydrogen bubble chamber at the JINR is described. It can be used for scanning films 50 or 35 mm wide. The projection system of the table permits one to simultaneously look over 4 films with the maximum dimensions of 50 × 150 mm^2 by an increase of 15× in the plane of the table. Measuring systems are to be established on the table to assure the operation of the automatic scanning device. (tr-auth)

27417 OPERATION OF A BUBBLE CHAMBER FILLED WITH FREON BROMIDE. Danil'chenko, I. A.; Kuznetsov, E. P.; Parshin, E. A. (Inst. of High Energy Physics, Serpukhov, USSR). Prib. Tekh. Eksp.; No. 6, 33-5(Nov-Dec 1969). (In Russian).

Results of investigation of the sensitivity of freon bromide CF_3Br to ionizing radiation are given. (tr-auth)

27418 STUDY OF THE RADIOPROTECTIVE EFFECTS OF CERTAIN ANTIBIOTICS ON PLANTS. Il'ina, G. V.; Kuznetsova, N. N.; Rydkii, S. G. Vestn. Mosk. Univ., Ser. Biol., Pedol.; No. 1, 56-63(1968). (In Russian).

The treatment of wheat seeds with a solution of trichothecine before γ irradiation had a positive influence on the productivity of wheat. However this positive action was manifested only within definite dose limits of irradiation. Beginning with a dose of 2000 R, which caused the strong sterility of the wheat heads, there were positive effects from trichothecine. The treatment of wheat seeds with a solution of trichothecine after their irradiation had not essential influence on non-fertile wheats, but eliminated the negative action of irradiation on the harvest of grain. In the case of the positive effects of trichothecine on the harvest of plants, changes of the biochemical processes that were noted upon irradiation did not occur. Negative aftereffects of trichothecine on plants of the second generation were not observed. (tr-auth)

27419 HIGH SENSITIVITY DOUBLE ON LINE QUANTAMETER FOR BUBBLE CHAMBER EXPERIMENTS. Coli, M.; Stella, B. (CNEN, Frascati, Italy). Nucl. Instrum. Methods; 80: 104-8(1970).

One on line quantameter for low intensity γ ray beam operation is described having two measuring channels for internal control; one for counting of the γ quanta of the beam and the other for the integral measurement of the beam intensity. The detector was a lead converter followed by a plastic scintillator. The results are digitally displaced on the chamber pictures. Big efforts were made to achieve stability of the system against aging and ambient temperature. (auth)

27420 SPARK CHAMBERS. Allkofer, Otto Claus. Munich; Verlag Karl Thiemig KG (1969). 256p. $15.00.

Various spark chamber types are considered. Among these are multiplate, track, streamer, projection, sonic, and wire spark

chambers. Also electronic circuits, applications, and comparison with other detector types are discussed. A historical survey is given. (J.F.P.)

Radiation Dosimeters

Refer also to abstracts 27352, 27353, 27471, 27478, and 27593.

27421 (CONF-690540–, pp 119-25) TRITIUM PERSONNEL DOSIMETRY WITH FILM DOSIMETERS. David, J.; Wasilewski, A. (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Strahlenschutz). (In German).

Newly developed film dosimeters for monitoring tritium exposure of personnel were studied and found not sensitive enough to serve under practical circumstances. A new type of highly sensitive film was investigated in experiments with well-defined amounts of tritium water vapor. Within the dose ranges of interest, distinct blackening occurred and was approximately proportional to the amount of tritium. The degree of blackening, however, depended strongly upon the storage time between exposure and development, especially at brief exposure periods. To enable standardization, it was suggested that a definite storage time be established. Six diagrams are presented. (H.B.G.)

27422 (CONF-690540–, pp 441-63) DOSIMETRY WITH EXOELECTRONS. Kramer, J. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). (In German).

Exoelectron emission in solid state physics is discussed and its possibilities in photography, chemistry, and dosimetry of ionizing radiation were analyzed. Experimentally, calcium sulfate, barium sulfate, and beryllium sulfate were studied. To obtain reliable dosimeters, these chemicals were mixed with graphite. Preparation and application of actual dosimeters are described. Twenty graphs are included. (H.B.G.)

27423 (CONF-690540–, pp 464-70) MEASURING AGGREGATE FOR RAPID EVALUATION OF EXOELECTRON DOSIMETERS. Engelland, W. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). (In German).

For personnel monitoring, an exoelectron dosimeter was developed. It consisted of a thin graphite plate on which beryllium oxide was deposited. For measuring the exoelectron emission after thermal stimulation, a special heatable methane-gas flow counter was constructed. The dosimeter was placed on the hot plate and the integral of the glow curve measured. The total impulse count then was proportional to the total dose of ionizing radiation. The lower limit of sensitivity was 30 mr while the higher limit was 60 r. Methods and results are presented in six graphs. (H.B.G.)

27424 (CONF-690540–, pp 471-81) MEASUREMENT CONDITIONS AND REPRODUCIBILITY OF TLD-100 DOSIMETER FOR HIGH-ENERGY PHOTON AND ELECTRON BEAMS. Rassow, J.; Strueter, H.-D. (Ruhr Univ., Essen (West Germany)). (In German).

Lithium fluoride dosimeters were studied as to reliability and energy dependence. Only dosimeters annealed simultaneously are comparable. Tolerances indicated by manufacturers were unreliable, and the sensitivity of dosimeters varied up to 20% from the nominal value. Therefore, careful calibration of each dosimeter was necessary. Comparison of measurements with ^{60}Co radiation and 42-MeV betatron-produced electron radiation and bremsstrahlung showed an energy dependence of ±2%. Lithium fluoride dosimeters, because of their small size and independency of energy, proved superior in many respects to other dosimeters. (H.B.G.)

27425 (CONF-690540–, pp 482-9) THERMOLUMINESCENCE MEASUREMENTS ON Ag-DOPED PHOSPHATE GLASSES. Regulla, Dieter (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Strahlenschutz). (In German).

Phosphate glass showed radiophotoluminescence as well as radiothermoluminescence. The radiothermoluminescence was studied following exposure to high doses of ^{137}Cs γ radiation. The total light emitted during the heating of the phosphate glass proved to be a suitable dose indicator within the range from 1 kr to 10 Mr. Following thermal stabilization, no fading occurred within one week after exposure. (H.B.G.)

27426 (CONF-690540–, pp 490-500) PRACTICAL USES OF DEPTH-DOSE MEASUREMENTS IN SILVER-ACTIVATED PHOSPHATE GLASS DOSIMETERS. Kiefer, H.; Piesch, E. (Kernforschungszentrum, Karlsruhe (West Germany)). (In German).

A differential method is described for the measuring of luminescence in silver-activated phosphate glass dosimeters. The technique permits determination of radiation energy, half-value layers, and energy distribution in medical and technical x-ray installations. It also permits personnel monitoring in isotope laboratories, especially those handling plutonium and americium. The principle of the method is as follows: the glass dosimeter is moved along the x-axis by a motor and differentially exposed to 0.3 mm optical slit; the glass is stimulated in the y axis, and luminescence is measured in the z axis. (H.B.G.)

27427 (CONF-690540–, pp 501-4) TESTING AND ROUTINE USE OF GLASS DOSIMETERS IN THE FRAMEWORK OF AN OFFICIAL PERSONNEL DOSE MEASUREMENT PLACE. Schelikes, A.; Maier, E.; Narrog, J. (Landesinstitut fuer Arbeitsschutz und Arbeitsmedizin, Karlsruhe (West Germany)). (In German).

The state institute for personnel protection at Karlsruhe conducted a large scale experiment by distributing 15,000 glass dosimeters. Results showed feasibility of the procedure. From an economic standpoint, however, evaluation of glass dosimeters was more time consuming than that of film dosimeters. At the present time, large scale use of glass dosimeters is justified only when readings can be made in periods exceeding three months. (H.B.G.)

27428 (CONF-690540–, pp 517-23) CALORIMETRIC MEASUREMENTS OF THE INTENSITY AND DOSE RATES OF IONIZING RADIATION. Schmidt, Th.; Saebel, M. (Erlangen-Nuernberg Univ. (West Germany). Institut fuer Physikalische und Medizinische Strahlenkunde). (In German).

A calorimeter was built for dose measurements of ionizing radiation below 40 keV. The calorimeter consists of a gold absorber in high vacuum with a thermocouple readout. Error analysis showed a dose accuracy within ±1%. (H.B.G.)

27429 (CONF-690540–, pp 524-31) A SELF-CHARGING ROENTGEN DOSIMETER WITH EFFICIENT UTILIZATION OF PHOTO AND COMPTON EFFECTS. Speyer, Klaus (Allgemeine Elektricitaets-Gesellschaft, AEG-Telefunken, Ulm (West Germany)). (In German).

A new type pocket dosimeter was developed which consists of the roentgen detection element, the electrometer, and the optical system. The roentgen detection element consists of an outer electrode of lead and an inner electrode of carbon. Because of the difference in atomic number between lead and carbon, x radiation produces a voltage difference between the two electrodes which is indicated by the electrometer. Advantages of the new dosimeter are stability of zero point, maintenance of a given charge for long times, and no saturation effects at high dose rates. (H.B.G.)

27430 (CONF-690540–, pp 532-7) FRICKE DOSIMETER AT A BETATRON WITH 35-MeV ELECTRON BEAMS. Pluemecke, Manfred. (In German).

Ampules of glass and various plastics including Teflon, polyethylene, and polystyrene were tested for containing the ferrosulfate solution for Fricke dosimetry of 35-MeV electrons. Teflon, in spite of its high specific gravity, proved to be the best container material. Results are presented graphically. (H.B.G.)

27431 (CONF-690540–, pp 576-85) DOSIMETRY OF FAST NEUTRONS BY MICRODOSIMETRIC METHODS. Krueger, H. (Marburg Univ. (West Germany)). (In German).

To measure neutron doses in tissue-equivalent phantoms, Rossi spherical proportional counters with 1 and 5 cm diameters were constructed. Principles of the construction and calibration are presented in five figures. Experimentally, the devices were tested with 3 and 15 MeV neutrons. Difficulties encountered during the measurement and interpretation of results are discussed. (H.B.G.)

27432 (HASL-226) ESTIMATING STRAY PHOTON SPECTRA AND DOSE ABOVE 25 MeV NEAR THE TRANSVERSE SHIELDING OF A PROTON SYNCHROTRON. Bennett, B. G.; McLaughlin, J. E.; O'Brien, K.; Weinstein, M. S. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Apr 1970. 14p. Dep. CFSTI.

Several stray photon energy spectra from 25 to 400 MeV were measured at a high energy accelerator with a shower spectrometer consisting of lead spheres and ^{7}LiF dosimeters. The spectra are relatively smooth and decline approximately as E^{-3} with increasing energy. The contribution to the total radiation dose equivalent by these energetic photons is provisionally estimated to be about 7%. Though the shower spectrometer system is cumbersome and would benefit from further study of its response, it shows promise for investigating leakage photons at selected locations outside shields. (auth)

27433 (ISS-69/31) DOSIMETRY OF THE γ RADIATION FROM A ^{60}Co SOURCE BY MEANS OF FRICKE'S FERROUS SULFATE METHOD. Araco, A.; Grisanti, A.; Tori, P. (Istituto Superiore de Sanita, Rome (Italy). Laboratori de Fisica). 25 Jul 1969. 15p. (In Italian). Dep. CFSTI (U.S. Sales Only).

The ferrous sulfate chemical dosimeter was used to determine the absorbed radiation dosage for a high activity ^{60}Co γ source. (auth)

27434 (RD/B/N-1611) DOSPEC: A C.E.G.B. USERCODE PROGRAM FOR ANALYSING DATA FROM THE FOUR-DETECTOR DOSE SPECTROMETER. Longworth, J. P. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar 1970. 9p. Dep. CFSTI (U. S. Sales Only).

DOSPEC was written to calculate dose in the four energy regions: thermal, 0.5 eV-30 keV, 30 keV-150 keV, and 150 keV-10 MeV, from counts obtained with four detectors. These included a 12EB40 BF_3 counter, a Basson counter, an FN2/3 fast neutron counter and an Andersson-Braun Rem counter. The statistical errors and Albedo dosimeter spectrum factor are also calculated. (auth) (UK)

27435 SOLID STATE DOSIMETRY. Proceedings of the NATO Summer School Held at Brussels, Belgium, September 4-16, 1967. Amelinckx, S.; Batz, B.; Strumane, R. (eds.). New York; Gordon and Breach, Science Publishers, Inc. (1969). 741p. $48.00. (CONF-670976).

A total of 22 papers is presented on topics related to radiation monitoring in health physics, using solid-state methods: crystal defects, radiation units, radiobiology, luminescence, color centers, photographic processes, magnetic effects, radiation damage, dosimetry, personnel monitoring, etc. Separate abstracts were prepared for all of the papers. (D.L.C.)

For abstracts of individual papers see: 27351-27353, 27436-27449, 27623, 28411, 28412, 28439, and 28440.

27436 UNITS IN DOSIMETRY AND RADIOPROTECTION. Duhamel, F. (CEA, Paris). pp 43-63 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

A review is given of the basic ideas upon which the definitions of dosimetric parameters and units are built. The parameters related to the motion of dose, parameters used in radioprotection dosimetry, and parameters related to the irradiated substances and to dosimetric means are considered. The relation of the parameters to each other is discussed. (D.L.C.)

27437 THEORY OF LUMINESCENCE. Schulman, James H. (Naval Research Lab., Washington, D. C.). pp 107-52 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

Topics include general aspects of luminescence, radiation-induced imperfections in solids-color centers, radiophotoluminescence, radiophotoluminescent dosimeters, thermoluminescence, thermoluminescent dosimeters, and other luminescent methods of dosimetry (infrared-stimulated luminescence dosimetry and luminescence degradation dosimetry). (52 references) (W.H.K.)

27438 PRINCIPLES AND BASIC DOSIMETRIC PROPERTIES OF RADIOPHOTOLUMINESCENCE IN SILVER-ACTIVATED GLASSES. Becker, K. (Oak Ridge National Lab., Tenn.). pp 153-92 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

A brief history and definition of radiophotoluminescence (RPL) are presented, and the theory of RPL is discussed. Also, the dosimetric properties of RPL glasses are described including low pre-dose; high sensitivity; low energy dependence; stability; fast build-up and slow fading; desired neutron sensitivity; low dose-rate, LET, temperature, and directional dependence; response to electrons and charged particles; and good dynamic range and accuracy. (W.H.K.)

27439 RADIATION INDUCED DEFECTS IN FERROMAGNETIC MATERIALS. Dautreppe, D. (CEN, Grenoble, France). pp 323-41 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

Radiation sensitive properties of ferromagnetic materials which can be used as monitors for dosimetry are discussed. In the pure or doped ferromagnetic metals, the magnetic after effects can be used in the range of 10^{15} nvt. In alloys the most sensitive property is the induced magnetic anisotropy (some 10^{15} nvt) but a complicated apparatus is needed. The initial permeability can be used but the same reproducibility would require special studies. Also, deformation of the hysteresis loop by neutron irradiation is discussed and shown graphically for various neutron fluxes in the 10^{18} n cm^{-2} range. (48 references). (W.H.K.)

27440 DOSIMETRY OF HIGH-ENERGY RADIATION FOR RADIOBIOLOGY AND RADIATION PROTECTION PURPOSES. Baarli, J. (CERN, Geneva). pp 345-74 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

Dosimetry of high-energy proton beams, pion beams, muons, and very high-energy neutron radiations for radiobiological studies is discussed. Also, dosimetry for protection from high-energy radiations around particle accelerators is considered. (18 references). (W.H.K.)

27441 RADIATION-INDUCED ELECTRICAL RESISTIVITY IN PURE METALS. Nihoul, J.; Stals, L. (SCK-CEN, Mol, Belgium). pp 445-61 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

Defect-induced resistivity increments in pure metals are described including Matthiessen's law for the temperature effect and the size effect. Resistometric data on neutron-irradiated metals for damage production and recovery of defects are discussed. Possibilities of the use of a metallic specimen for resistometric neutron dosimetry are considered. (36 references). (W.H.K.)

27442 SOME EXPERIMENTS AND DIFFICULTIES ON RELATING RADIATION DAMAGE TO NEUTRON DOSE IN SOLIDS. Van den Bosch, A. (SCK, Mol, Belgium). pp 463-80 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

The thermal neutron absorption and F-center absorption in lithium fluoride detectors are discussed, and the lithium fluoride detector is briefly compared to the activation detector. Also, the density decrease in quartz crystals as a function of fast neutron dose is discussed as a possible method for fast neutron dosimetry. (20 references). (W.H.K.)

27443 HEALTH PHYSICS REQUIREMENTS FOR DOSIMETRY IN NUCLEAR ESTABLISHMENTS. Langmead, W. A. (Atomic Energy Research Establishment, Harwell, Eng.). pp 483-551 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

The development of personnel monitoring philosophy and dosimeters at UKAEA is described. The operation, performance, and advantages and disadvantages of photographic film, nuclear emulsions, thermoluminescent dosimeters, and radiophotoluminescent dosimeters are discussed. (57 references). (W.H.K.)

27444 PERSONNEL MONITORING WITH RADIOPHOTOLUMINESCENT DOSIMETERS. Maushart, R. (Kernforschungszentrum, Karlsruhe, Ger.). pp 553-84 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

The practical use of glass radiophotoluminescent dosimeters is discussed including energy compensation methods, routine dosimeter for x- and gamma-radiation, evaluation equipment, dose evaluation methods and procedures, and the evaluation of a monitoring service. A list of commercially available glass dosimeter readers is included. (23 references). (W.H.K.)

27445 THE TECHNICAL CHARACTERISTICS OF AND APPLICATIONS FOR PHOSPHOR-TEFLON THERMOLUMINESCENT DOSIMETERS. Bjarngard, Bengt; Jones, Douglas (Control for Radiation, Inc., Cambridge, Mass.). pp 585-634 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

Phosphor–Teflon dosimeters have been in use for some three years. The production technique and the physical properties of LiF, CaF_2: Mn, $CaSO_4$: Mn, and Li_2B_4O: Mn–Teflon dosimeters are described. Precision at various dose levels and problems associated with reuse of the dosimeters are discussed together with fading and energy dependence. The wide range of dosimetric characteristics of these dosimeters has allowed their use in almost all branches of radiation dosimetry. Special dosimeters have been developed for application in clinical dosimetry, especially an intracavitary probe and an interstitial needle. LiF–Teflon discs are used for finger dosimetry and for personnel badge dosimetry. Special applications of very thin dosimeters, about 10 microns, illustrate the great versatility of dosimeter shape and size that is a very important capability of the phosphor–Teflon dosimeters. (43 references). (auth)

27446 FIELD EXPERIENCE WITH THERMOLUMINESCENT DOSIMETERS. Cusimano, John P.; Cipperley, Foster V.; Culley, John C. (Atomic Energy Commission, Idaho Falls, Idaho). pp 635-44 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

A routine system of personnel dosimetry utilizing the phenomena of thermoluminescence has been developed at the National Reactor Testing Station. Research in thermoluminescent application techniques was initiated in 1965 for the purpose of developing a suitable system for long-term monitoring of low-exposure-probability personnel. The new routine dosimetry system utilizes two lithium fluoride–Teflon disc dosimeters held in a plastic dosimeter retainer that is the same size and shape as a standard film packet in the National Reactor Testing Station dosimetry badge. The field experience using the new system since its application in November 1966 is presented. (auth)

27447 PROPERTIES OF DIFFERENT PHOSPHORS AS USED IN A PACKAGED TLD SYSTEM; MULTIPLE READINGS OF DOSE BY U.V. LIGHT TRANSFER. Brooke, C. (Manufacture Belge de Lampes et de Materiel Electronique, Brussels). pp 645-71 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

Topics include properties of different packaged phosphors, glow curves and decay of information, efficiency and spectral sensitivity, linearity and radiation damage, energy response, beta response, and the effect of exposure to light on natural based calcium fluoride dosimeter. (W.H.K.)

27448 FILM DOSIMETRY AND CRITICALITY DOSIMETERS. Boulenger, R.; Ghoos, L. (CEN, Mol, Belgium). pp 673-94 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

The purpose and methods for personnel monitoring with photographic film are discussed. Characteristics of the film, choice of the shielding windows for the holder, development and calibration, determination of doses, characteristics of the dosimeter, and use as criticality dosimeters are described. (W.H.K.)

27449 SURVEY OF SOLID STATE DOSIMETRY. Cameron, John R. (Univ. of Wisconsin, Madison). pp 695-721 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

Topics discussed include characteristics of lithium fluoride dosimeters, supralinearity of lithium fluoride, use of thermoluminescent dosimeters (TLD) for intercomparisons, fading in lithium fluoride, comparison of various TLD phosphors, a simple TLD reader, p–i–n solid-state detectors, scintillation detectors, and dye dosimeters. A list of manufacturers of TLD equipment is included. (26 references). (W.H.K.)

27450 MEASUREMENT OF ABSORBED ENERGY OF BREMSSTRAHLUNG AND BEAMS OF FAST ELECTRONS WITH THE AID OF GRAPHITE CALORIMETER. Ermakov, I. A.; Sinitsyna, A. P. (Central Research Inst. of Roentgen-Radiology, Moscow). Med. Radiol.; 15: No. 3, 65-71(Mar 1970). (In Russian).

The design of a calorimeter is described and the results of measurements of the absorbed energy from beams of fast electrons and bremsstrahlung from betatron B-4E are given. (auth)

27451 VARIATION WITH HARDNESS OF GLASS THERMOLUMINESCENT DOSIMETER IKS. Bochvar, I. A.; Gimadova, T. I.; Keirim-Markus, I. B.; Sergeeva, N. A. (Inst. of Biophysics, Moscow). Prib. Tekh. Eksp.; No. 6, 66-8(Nov-Dec 1969). (In Russian).

The variation with hardness of γ radiation was investigated for glass thermoluminescent dosimeters composed of $Al_2O_3 \cdot 3P_2O_5$ (50%), $MgO \cdot P_2O_5$ (50%), MnO_2 (0.1%) (wt %) in the form of plates $4 \times 15 \times 15$ mm³ and discs 8×1 mm². Compensating filters were selected, which provide variations of hardness by ±20% from 30 keV to 1.25 MeV for normal incidence of radiation on the dosimeter and ±20% for 35 keV and above for isotropic incidence of the radiation. It is shown that variation with hardness of the dosimeter IKS is no worse than dosimeters based on CaF_2(Mn) and LiF. (tr-auth)

27452 DOSE READER USING THERMALLY STIMULATED EXOELECTRON EMISSION FROM LITHIUM FLUORIDE CRYSTALS. Lillicrap, S. C. (Royal Marsden Hospital, Sutton, Eng.). Brit. J. Radiol.; 43: 277-8(Apr 1970).

Modifications carried out on a commercially available windowless gas-flow Geiger counter for use as an exoelectron dose reader are described. The reproducibility of readings for doses over 1 rad was found to be 5 per cent and the smallest dose measurable, about 100 m rad. A comparison is given between this technique and that of thermoluminescence dosimetry. (UK)

27453 SENSITIVE CERAMIC BeO-TSEE DOSIMETER. Robinson, E. M.; Oberhofer, M. (Oak Ridge National Lab., Tenn.). Health Phys.; 18: 434-7(Apr 1970).

Experiments were carried out on thermally stimulated exoelectron emission (TSEE) dosimeters using BeO discs on the surface of which a thin layer of gold had been vacuum deposited. A minimum dose of 10μR was detected by using a high temperature TSEE G.M. The upper dose limit was rather low due to the dead time of the counter (200 μsec). If dead-time correction was applied, several tens of mR could be measured. Reproducibility was also investigated. It was concluded that these instruments looked most promising for the future development of a routine dosimeter. (UK)

27454 ON THE QUESTION OF PERSONNEL DOSIMETRY BY THE THERMOLUMINESCENCE METHOD. Dresel, H.; Stoffel, F. (Univ., Freiburg i. B.). Kerntechnik; 12: 124-7 (Mar 1970). (In German and English).

For the routine determination of radiation exposure of personnel by means of TL, the possibility of an unequivocal attachment of LiF-ribbon (Harshaw) to certain controlled persons is described. Alterations in the behavior of the ribbons concerning the sensitivity for radiation exposure, caused by higher radiation doses, annealing (400°C) etc., are registered on a plate of "VESPEL" (heat resistant up to 450°C) in the middle of which the LiF-ribbon permanently is inserted in a hole. With this information, a rather accurate determination of the exposure dose should be possible. A suitable badge for mechanical protection of the survey meter (consisting of two VESPEL-plates with LiF-ribbons) is described. Also, the determination of the exposure dose by means of the Harshaw model type 2000 A and 2000 B, taking account of some troubling phenomenons, is discussed. (auth)

27455 NEW METHOD FOR RADIOTHERMOLUMINESCENT RESEARCH. Levi, S. M.; Mishev, I. T.; Radicheva, M. A. Compt. Rend Acad. Bulg. Sci.; 23: 25-7(1970).

A method for improving the resolution of the peaks in the glow curve from thermoluminescent materials of natural fluorites is discussed. The method involves a step-like heating of the phosphor rather than the usual linear heating method. (W.H.K.)

27456 BREMSSTRAHLUNG DOSIMETRY. Baciu, G. (Inst. of Nuclear Physics, Bucharest). Stud. Cercet. Fiz.; 22: 189-218 (1970). (In Rumanian).

The topics discussed are bremsstrahlung from the betatron, an aluminum thick-walled ionization chamber, a radiation quantity measuring system, and a dosimetric calibration system. (J.F.P.)

27457 PERSONNEL DOSIMETERS OF PHOTOGRAPHIC FILM (RADIOLOGICAL). Energ. Nucl. (Madrid); 13: 441-8(Sep-Oct 1969). (In Spanish).

The UNE guidelines for photographic film personnel dosimeters, used for the determination of the exposures produced by ionizing radiation and designed to be worn on the chest or wrist for measurement of the x or γ radiations below 3 MeV, are summarized. A description is given of these dosimeters and their classification and designations are outlined. The specifications are tabulated. The technique for testing the dosimeters is given, and the operational procedure is outlined step by step. (J.S.R.)

Radiometric Instruments

Refer also to abstract 27106.

27458 (Y-1714) COMPTON SCATTERING TECHNIQUE FOR MEASURING THE AREAL DENSITY OF GLASS-REINFORCED STRUCTURES. White, J. D. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 7 May 1970. Contract W-7405-eng-26. 20p. Dep. CFSTI.

An investigation has shown the applicability of a new technique for the one-sided nondestructive measurement of the mass uniformity of glass-reinforced laminates. The number of gammas scattered into a detector through 135 degrees by Compton interactions was found to be a smooth function of the mass per unit area of the specimen over a wide range (0.27–2.07 gms/cm^2). (auth)

27459 MEASUREMENTS OF THE WATER CONTENT OF SAMPLES OF UNSATURATED SOIL BY THE ATTENUATION OF γ RADIATION EMITTED BY AN ^{241}Am SOURCE. Cisler, Jaromir; Thony, Jean-Louis; Vaghaud, Georges (Univ., Isere, France). Compt. Rend., Ser. A, 269: 982-5(17 Nov 1969). (In French).

A method is proposed for the nondestructive measurement of the water content of a sample of unsaturated soil based on the attenuation of γ radiation emitted by an americium-241 source. The respective advantages arising from the use of this isotope or cesium-137 are studied. (tr-auth)

27460 CHOICE OF THE INITIAL THRESHOLD FOR REGISTRATION OF IMPULSES AND OPTIMAL CONDITIONS OF GAMMA-LOGGING BY SCINTILLATION DETECTORS. Lerman, G. I. (Ministry of Geology, Kiev). Geofiz. Sb., Akad. Nauk Ukr. SSR, Inst. Geofiz.; No. 33, 84-94(1970). (In Russian).

The article contains the results of experimental and methodical researches with apparatus DPCT-1 and DPCT-2 carried out in 1966 and 1967. Pointing to the importance of the initial threshold for registering the impulses less than 50 keV to ensure the maximum sensitivity and stability of integral readings of the apparatus, the effect of electric parameters of photoelectronic multipliers, the quality of detectors, and the wear level of the amplitude discriminator of the hole shell on the above-mentioned threshold are discussed. At the same time the combined method is suggested of tuning the threshold by proper selection of the feed tension and wear level of the amplitude discriminator. The concrete conditions are analyzed under which one of these methods is dominating. Choice of the optimal conditions for gamma-logging is suggested, taking into account the variability and statistical fluctuations of the normal field of the enclosing rocks, measurement errors, and decrease of the real intensity of the radioactive beds. The conditions of logging for lithologic separation of the selection and that for the search of radioactive elements are clearly differentiated. The method for combination of these two problems is suggested. (auth)

27461 IMPROVEMENTS IN OR RELATING TO PARTICLE SIZE ANALYSIS. Laundy, Brian John Russell; Hardwick, William Horton (to United Kingdom Atomic Energy Authority). British Patent 1,189,328. 22 Apr 1970. Filed 12 Sep 1967.

Reference is made to particle size analysis by the technique of β-particle backscattering. In one application of this technique the size distribution of a powder is determined by measuring the build up of a sediment formed by the particles falling under gravity from a suspension. This technique cannot, however, be used for very small particles, of the order of 1μ or less since the perturbations introduced by the Brownian movement are significant and, in the limit, no settlement takes place. In the method described a suspension of the particles in a fluid of suitable viscosity is formed and centrifugal separation is applied; during such separation the sediment build-up is continuously measured by β-particle backscattering. The β-particle detection means may comprise an annular ionization chamber, but preferably comprises an annular plastic scintillator, which also functions as a light guide, coupled with a photomultiplier. Conventional counting and print out devices may be provided. The β-source may be ^{90}Sr. (UK)

27462 TEMPERATURE STABILIZATION OF GAMMA RAY TRANSMISSION EQUIPMENT. Reginato, Robert J.; Stout, Karl (Harshaw Chemical Co., Cleveland). Soil Sci. Soc. Amer., Proc.; 34: 152-3(Jan-Feb 1970).

Accurate measurements of water content of soil in situ can now be made using an improved gamma ray transmission method. Prior to this development, existing equipment tried in the field responded to temperature fluctuations as well as density and water content changes. With the new method, the nuclear counting system is stabilized on a reference ^{60}Co gamma ray source attached to the detector assembly. Density changes are then measured with a ^{137}Cs gamma ray source about 30 cm away from the detector. In laboratory tests, similar attenuated count rates were obtained for ^{137}Cs gamma rays through a standard absorber while the temperature was varied from 5 to 33C. (auth)

27463 FUNDAMENTAL STUDY ON INDUSTRIAL MEASUREMENTS BY MEANS OF BACKSCATTERED GAMMA-RAYS. PART I. USE OF COLLIMATED INCIDENT BEAM. Shibata, Keizo; Wakabayashi, Nobuo; Fujii, Mizuhiko; Ueda, Katsuhiko (Kobe Univ., Japan). Mem. Fac. Eng., Kobe Univ.; No. 16, 1-15(Mar 1970).

As a fundamental study of the thickness gauge, level- or density-meter employing backscattered gamma-rays, the spectra of the radiation scattered by steel plates with or without water behind these plates were observed. The incoming beam from ^{137}Cs 0.1 Ci was collimated by a hole 6 mm in diameter. The detector used was a NaI(Tl) scintillation counter. When the scattering angle was not large, the energy spectrum showed two main peaks: a higher energy peak due to single-scattered photons, and a lower energy peak due to multiple-scattered photons which come more from the water than the steel plate. Though the energy band of the higher peak is suitable for thickness measurement of a vessel wall and that of the lower peak for a level- or density-meter, it is also possible by some geometrical arrangement of the apparatus to detect mainly the photons scattered either by the vessel wall or its contents It is shown that the instruments employing backscattered gamma-rays may be evaluated from the point of view of the error caused by the presence of liquid in a vessel for a wall-thickness gauge, and of the necessary minimum product of the radioactivity and the time constant for a level- or density-meter. (auth) (NSA of Japan)

Miscellaneous Instruments and Components

Refer also to abstracts 27598, 27599, 28464, 28691, 28732, 29042, and 29078.

27464 (AAEC/TM-525) AN EXTENDED ADDRESSING FEATURE FOR A PDP8/L COMPUTER. Ellis, P. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec 1969. 11p. Dep. CFSTI (U. S. Sales Only).

A description is given of the operation of an index register addressing scheme for a PDP8/L computer, which provides more flexibility in a multi-user environment. This extend or index mode requires a small modification to the standard PDP8/L central processor and does not affect its normal operation unless required by program. (auth)

27465 (ANL-7648) WORKING EXPERIENCE WITH HIGH-TEMPERATURE STRAIN GAGES. Marchertas, A. H.; Fiala, C.; Fistedis, S. H. (Argonne National Lab., Ill.). Dec 1969. Contract W-31-109-eng-38. 39p. Dep. CFSTI.

Experience obtained with the Baldwin–Lima–Hamilton (BLH) Type FNWFB9–50–12 fullbridge, weldable, high-temperature strain gage is described. Circumstances leading to the investigation and reasons for failing to meet its original objectives are described. Shortcomings of this gage type, which are similar to those of other high-temperature gages, are discussed for the benefit of users of high-temperature gages. Testing of the gages at the FARET fuel assembly test loop is discussed. (auth)

27466 (ANU-P-490) COOLING DEVICE FOR END-ON PHOTOMULTIPLIERS. Carriveau, G. W. (Australian National Univ., Canberra. Research School of Physical Sciences). [1970]. 5p. Dep. CFSTI (U. S. Sales Only).

A simply constructed, end-on type photomultiplier (EMI 6256S) cooling device is described, capable of maintaining a preset temperature by use of cooled dry gas. Through the use of this design, heated windows and difficulties of condensation are avoided. (auth)

27467 (CSIRO-Trans-10098) RADIOMETERS WITH PARAMETRIC AMPLIFIERS OF 1.6 AND 3.3 cm WAVELENGTHS FOR THE RT-22 RADIO-TELESCOPE. Bibinova, V. P.; (and others). Translated by G. Losonci from Tr. Fiz. Inst., Akad. Nauk SSSR; 47: 149-52(1969). 5p. Dep. CFSTI (U. S. Sales Only).

Parametric amplifiers with low noise level and a wideband intermediate frequency amplifier were used for increasing the radiometer sensitivity of the RT-22 telescope. The measured fluctuation sensitivities of the radiometers were 0.12 and 0.3°K at τ = 1 sec for λ = 3.3 cm and 1.6 cm. The 3 cm radiometer is more reliable and its stability has been proven over prolonged operation. Venus radio emission data have been obtained on the 1.6 cm radiometer. (Australia)

27468 (GEMP-737) LIFE TESTING SMALL DIAMETER THERMOCOUPLES AS A FUNCTION OF THERMAL CYCLING. Baxter, W. G.; Conner, D. E.; Rauch, W. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Nov 1969. Contract AT(40-1)-2847. 58p. Dep. CFSTI.

An air atmosphere electrically heated furnace for 1200°F operation was designed for thermal cycling (1200°-600°F) by means of steam injection. This unit has operated in excess of 3600 cycles during four test periods and has clearly demonstrated the superior performance of certain commercially available small diameter (0.0625" OD), MgO insulated, stainless steel sheathed thermocouples under the specific thermal cycling conditions experienced. Exceptional thermal cycling stability was experienced with the small diameter, MgO insulated, stainless steel sheathed Copper-Constantan thermocouples. No thermocouple in this system failed in testing. Also, Chromel-Alumel thermocouples were tested. Recommendations for further testing these thermocouples for the LMFBR program are given. (W.H.K.)

27469 (N-69-36310) DEVELOPMENT OF FIELD IONIZATION FOR THE IMPROVEMENT OF MASS SPECTROMETRY. Interim Scientific Report, March 25, 1968-March 25, 1969. Bryant, Paul J.; Phillips, James M. (Missouri Univ., Kansas City. Dept. of Physics). Contract NAS12-646. 58p. (NASA-CR-86223). CFSTI.

Described is the development of an efficient field ionization ion source and quadruple focusing system for the production of ions for mass spectrometry. A new carbon filament ionizer, designed and utilized on this program, has increased ion yield by two orders of magnitude. The new ionizer, coupled with an ion lens system designed for focusing and retarding the high energy field ions was successfully used as an ion source for a commercial quadruple mass spectrometer. The high ion yield obtained with the new type field ion sources, and the preliminary results with the mass spectrometer show the feasibility of practical applications. Ion yields were also computed from the transmission probabilities for an electron to pass through a molecular potential barrier. (auth) (USGRDR)

27470 (NP-18083) REPORT FOR THE YEAR 1968. (Kernforschungsanlage, Juelich (West Germany)). 249p. (In German). Dep. CFSTI (U. S. Sales Only).

The general development of the nuclear research installation organization is summarized. The large-scale projects at Juelich, usually in cooperation with other groups, were centered on the development of high temperature reactors and the design of the 300-MWe THTR prototype. The studies still in progress in botany and microbiology, zoology, medicine, physical chemistry, radiochemistry, chemical technology, high energy physics, nuclear physics, solid-state and neutron physics, engineering physics, reactor construction elements, reactor development, and plasma physics are summarized. Data from completed studies in these areas were published and these are tabulated. The development of scientific and engineering devices for these areas of study is discussed. All reports and publications are tabulated. (J.S.R.)

27471 RAPID SCANNING SPECTROMETER FOR THE REGION 200 TO 850 NM: APPLICATION TO THERMOLUMINESCENT EMISSION SPECTRA. Harris, A. M.; Jackson, J. H. (Central Electricity Generating Board, Berkeley, Eng.). J. Phys., E (London); 3: 374-6(May 1970).

A spectrometer capable of examining a varying light source is described; it was designed to scan the wavelength range 200-850 nm in about 0.5 s. The information may be additive with successive wavelength scans so that a time-integrated spectrum can be finally presented on a pulse-height analyser; this is in digital form and may readily be converted into a form suitable for computer analysis. Examples of the application of the instrument to the study of the thermoluminescent spectra of various materials are presented. (auth) (UK)

27472 SMALL-SIZE WIDE-RANGE IONIZATION MANOMETER. Koroleva, T. V.; Penchko, E. A. Prib. Tekh. Eksp.; No. 6, 160-2(Nov-Dec 1969). (In Russian).

A small-size ionization manometer for measurement of pressures in the range 3×10^{-1} to 10^{-10} torr was developed. High pressures are measured by the manometer without a magnetic field, and low pressures measured with an intrinsic or external magnetic field. (tr-auth)

27473 THE DETERMINATION OF THE PHOTON ENERGY SPECTRUM OF A FLASH X-RAY TUBE. Cracknell, A. P.; Hall, T. P. P.; Twidell, J. W.; Whitrow, R. J. (Univ. of Essex, Colchester, Eng.). Radiat. Eff.; 2: 233-42(Mar 1970).

The energy spectrum of a "Fexitron" flash x-ray generator marketed by Field Emission U. K. Ltd. and operated at 500 kV has been determined by measuring the attenuation of the single pulses through plane metal attenuators with LiF thermoluminescent dosimeters. The results have been analysed by two different iterative numerical procedures using tabulated attenuation coefficients to determine the distribution of photon fluence in the pulse. Other methods of analysis are discussed and estimates are made of the errors involved in the various methods. (auth)

27474 MANUAL CONTROLLER WITH PRESELECT FOR CAMAC SYSTEM. Halling, H.; Egl, W. (Oesterreichische Studiengesellschaft fuer Atomenergie, Seibersdorf, Austria). Nucl. Instrum. Methods; 80: 122-4(1970). (In German).

This instrument conforms to the CAMAC-System specified in the Publication "EUR 4100e." It is adapted to computers like PDP8L of DEC. The crates can be controlled directly by the PDP8L, without an additional logic interface (system controller). For simple automatic programs, for adjusting and optimizing experiments without computer the Camac Manual Control has been developed. The outputs of this adjustable hardware-programmer deliver the same electrical signals as the output of the PDP8L, thereby enabling the control of up to 7 crates. The purpose of the Manual Controller is to have the possibility to set a limited number of single instructions by pushbuttons as well as logical niveaus, e.g., inhibit, clear, initialize, read, write, print etc. The unit also allows an automatic control of the Camac devices by delivering a number of hardware instructions in automatic cycles. Data set by 6 decade switches are written into the addressed module register, the contents of registers can be displayed or printed out by a teletype. An array of switches enables the preselection of the addresses of registers to be printed out. (auth)

27475 SIMPLE, HIGH PERFORMANCE LINEAR GATE FOR NUCLEAR PHYSICS APPLICATIONS. Battista, A. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Nucl. Instrum. Methods; 80: 172-4(1970).

A very simple and fundamental way of performing high standard linear gating is described. The fundamentals involved, the design techniques and the results obtained are given. (auth)

27476 COMPUTER-CONTROLLED, THREE-STAGE MASS SPECTROMETER. Lagergren, C. R.; Stoffels, J. J. (Battelle Memorial Inst., Richland, Wash.). J. Mass Spectrom. Ion Phys.; 3: 429-38(Mar 1970).

A computer-controlled, three-stage mass spectrometer for heavy element isotope ratio measurements has been constructed. The spectrometer consists of two symmetric, 90° sector, magnetic analyzers of 12-in. radius in a zero-dispersion configuration followed by a symmetric, 90°, cylindrical, electrostatic analyzer also of 12-in. radius. This arrangement yields an abundance sensitivity of 10^9. A small on-line computer directly controls the mass spectrometer and processes digital ion-counting data from it. Any scheme of scanning the magnetic field or ion accelerating voltage and accumulating data can be programmed through the computer. (auth)

27477 DEVELOPMENT OF A HIGH-ABUNDANCE SENSITIVITY MASS SPECTROMETER AND ITS APPLICATION IN THE MEASUREMENT OF THE HALF-LIFE OF ^{53}Mn. Hohlfelder, Jacque Jerome. Minneapolis; Univ. of Minnesota (1968). 91p. Thesis.

The mass spectrometer which was developed for and used in the research described was designed to have a high abundance sensitivity. An abundance sensitivity of 5.7×10^7 for $\Delta M = 0.25$ unit at mass 40 was achieved by placing two double-focusing mass spectrometers in series. The use of a Daly-type ion scintillation detector of high ion detection efficiency (80 percent) and low background noise rate (1.8 counts per second) enabled the measurement of positive ion currents as low as 1×10^{-18} ampere and differing in intensity by as much as a factor of 1×10^7. From the measurement of the isotopic ratio: manganese-53/manganese-55 in manganese which was extracted from a fragment of the Canyon Diablo iron meteorite and from an independent measurement of the activity of the same Canyon Diablo manganese sample, the half-life of manganese-53 was calculated and found to be 10.2 ± 6.0 million years at a confidence level of 99.7 percent. The total manganese-53 contained in the Canyon Diablo meteorite fragment which was analyzed was found to be nearly that predicted by spallation model calculations. (Diss. Abstr. Int., B)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 28152.

27478 (ANL-7615, pp 201-3) PERMANENT DAMAGE OF ^{7}LiF THERMOLUMINESCENT DOSIMETERS BY FAST NEUTRONS.

Kastner, Jacob; Eckerman, Keith; Oltman, B. G.; Tedeschi, Pete (Argonne National Lab., Ill.).

It has been postulated that lattice heating may be the mechanism for the effects of fast neutrons on the gamma-ray response of TLD-700. In the experiment described, LiF was exposed to neutron energies of 6 to 14 MeV. The observed decrease in thermoluminescent response was established to be due in part to permanent damage of the dosimeter and definitely not attributable to lattice heating. (auth)

27479 (N-69-20777) DEGRADATION OF MULTIPLIER PHOTOTUBES EXPOSED TO SPATIAL RADIATIONS. Brown, M. John; Bae, M. S.; Dark, S. (Weston Instruments, Inc., College Park, Md.). Mar 1969. Contract NAS1-7648. 246p. (NASA-CR-1304). CFSTI.

The degradation of multiplier phototubes was determined from properties measured in situ during exposure to simulated spatial radiations. A complete analysis of the orbital environments for a specific spacecraft was accomplished to determine operational parameters of a phototube detector. The experimental apparatus was then arranged to provide the spatial environments at real time conditions. Exposure of four identical phototubes was conducted to evaluate the synergistic effect of combined radiations including solar, lunar, and earth irradiances and electron-proton accelerated particle radiations over a seven month period. The phototubes were fabricated for high stability using beryllium copper dynodes in each of fourteen stages and their spectral sensitivity was from 250 to 700 nanometers. Selection of the phototube was based on detector requirements in star mapping from an orbiting spacecraft. Laboratory test results indicate that the phototube is relatively stable when exposed to single radiation sources of solar and charged particles, but degrades when exposed to combined radiations, especially when the irradiation profile included lunar viewing. (auth) (USGRDR)

27480 (N-69-39540) SOLAR CELL RADIATION FLIGHT EXPERIMENT. Final Report, August 14, 1968-May 30, 1969. Dawson, W. P. (Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.). 30 May 1969. Contracts NAS7-100; JPL-952351. 138p. (NASA-CR-106227; SSD-90329-R). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

The primary objective of the Solar Cell Radiation Flight Experiment, scheduled for launch on the ATS-E spacecraft, is to provide high accuracy data permitting a technical evaluation of the effects of the radiation environments on solar cells. Data from the flight experiment and supplemental ground test program are a continuation of the work performed by other experimenters, and will provide design data required for extended spacecraft missions in synchronous orbit. The flight experiment includes two small solar panels mounted externally on the spacecraft. The two panels have a total of 80 solar cells, representing 16 solar cell configurations. In addition, the experiment has two signal processor units, required for data sampling and telemetry using the ATS-E telemetry system, and a payload regulator that activates the experiment via ground command. In addition to the design and fabrication of the flight experiment, a ground test program was run. Data resulting from this program were used as an aid in selecting the solar cell configurations for the flight experiment. (auth) (USGRDR)

27481 (N-70-18330) STUDY OF RADIATION EFFECTS IN SILICON SOLAR CELLS. Annual Report. Naber, J. A.; Passenheim, B. C.; Berger, R. A. (Gulf General Atomic, Inc., San Diego, Calif.). 23 Jan 1970. Contracts NAS7-100; JPL-952387. 105p. (NASA-CR-107954; GA-9909). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Radiation effects in lithium diffused bulk silicon were studied to ascertain the nature of the defects responsible for the degradation in output of silicon devices (solar cells) irradiated by space radiation. Results of neutron activation analysis for lithium were inconclusive for lightly diffused silicon but generally indicate greater lithium concentrations in heavily diffused silicon than were inferred from resistivity measurements. No impurity dependence was observed for the degradation rate of samples irradiated with fission neutrons. Nearly all the neutron damage was annealed by first order kinetics between 300 and 380 K. An electron spin resonance investigation of the Si-G7 (divacancy) and Si-G8 (phosphorus vacancy) centers in electron irradiated lithium diffused silicon indicated exceptionally low production rates. The low divacancy production rate was verified by infrared absorption measurements. (auth) (USGRDR)

27482 (N-70-18737) DEVELOPMENT OF LITHIUM DIFFUSED RADIATION RESISTANT SOLAR CELLS. Quarterly Report. Payne, P.; Somberg, H. (Heliotek, Sylmar, Calif.). 15 Jan 1970. Contracts NAS7-100; JPL-952547. 41p. (NASA-CR-108036). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Boron diffusion studies were performed. A process was successfully developed using a BBr_3 source. Good output was achieved and stresses were negligible as demonstrated by diffusing 2 × 6 cm size blanks that were only 0.006 inch thick. Humidity exposure tests showed that the solderless Ti-Ag contact on P/N cells is not humidity resistant. Cells made using an eight-hour lithium diffusion at 325°C have had very good efficiencies. In fact, the distribution curve of the 60 cells with these diffusion parameters showed that these cells had the highest efficiencies of any fabricated to date. (auth) (USGRDR)

27483 (N-70-20336) DEVELOPMENT OF RADIATION HARDENED LITHIUM-DOPED SOLAR CELLS. Final Report. Kendall, D. L.; Vineyard, R. A. (Texas Instruments Inc., Dallas). Jul 1969. Contracts NAS7-100; JPL-952248. 65p. (NASA-CR-108781; TI-3-69-37). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Two basic fabrication techniques were utilized on 600 1 × 2 cm cells. Variables investigated included lithium diffusion cycle and silicon crystal types. The solar cells were tested for conversion efficiency, short circuit current, and open circuit voltage under both tungsten and filtered-xenon light sources. Conversion efficiencies on lots 8, 9, and 10 averaged >12.5% under the tungsten light source calibrated at 100 mW/sq cm sunlight equivalent intensity. Sample cells from lot 5 averaged 10.4% AMO under the filtered-xenon solar simulator. Although lithium is generally observed in silicon as the interstitial donor, lithium substitutional acceptors were identified and their concentrations measured. Heavily boron-doped silicon was compensated by lithium and the resultant resistivity (apparent) was determined as a function of time. The electrical characteristics (Hall mobility, lifetime, etc.) of lithium-diffused silicon were measured. Impurity diffusion in silicon is reviewed with respect to solar cell characteristics and radiation damage. (auth) (USGRDR)

27484 (N-70-20665) A STUDY OF PROTON INDUCED EFFECTS ON REFLECTIVE SURFACES OF SPACE MIRRORS. Gillette, Roger B.; Kenyon, Bruce A. (Boeing Co., Seattle, Wash.). Feb 1970. Contract NAS1-7627. 94p. (NASA-CR-1532). CFSTI.

The results of a study on the effects of low energy protons on reflective surfaces for space optical systems are presented. The primary objective was to determine the effects on telescope mirror reflective surfaces of the proton radiation environment at synchronous earth orbit. Secondary objectives were to obtain information on surface finish characteristics and reflectance characteristics of three mirror substrates. Mirror test specimens evaluated included polished substrates of fused silica, Cer-Vit, and Kanigen-nickel-plated beryllium; coated with aluminum and overcoated with MgF_2. Also included were specimens of polished fused silica coated with aluminum and LiF. The experimental program studied the dependence of specular reflectance and scattering properties on: (1) proton integrated flux; (2) proton flux; (3) post-irradiation exposure to air; and (4) coating and substrate type. (auth) (USGRDR)

27485 (N-70-23098) EFFECTS OF NUCLEAR RADIATION ON A HIGH-RELIABILITY SILICON POWER DIODE. 2. ANALYSIS OF FORWARD ELECTRICAL CHARACTERISTICS. Been, Julian F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr 1970. 27p. (NASA-TN-D-5732; E-5296). CFSTI.

One hundred power diodes were irradiated in the NASA Plum Brook Reactor. The changes in forward electrical characteristics due to nuclear radiation were interpreted in terms of decreasing minority carrier lifetimes. The increase in forward voltage at high current densities was the most significant change. The pre- and post-irradiation data were analyzed in terms of n(+)-p-p(+)-type junction theory. The critical quantity was the ratio of the base width to the high-level diffusion length. Control of the ratio suggests a means of increasing the radiation tolerance of this type diode. The effects of spacecharge limiting were also considered. (auth) (USGRDR)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 27325.

Basic Processes

Refer also to abstracts 27326 and 27626.

27486 (STI/PUB-161) ISOTOPE STUDIES ON THE NITROGEN CHAIN. Proceedings Series. Proceedings of the Symposium on the Use of Isotopes in Studies of Nitrogen Metabolism in the Soil-Plant-Animal System, Held in Vienna, 28 August-1 September 1967. (International Atomic Energy Agency, Vienna (Austria)). 1968. 350p. (In several languages). (CONF-670852). IAEA $7.00.

Nuclear techniques are helping research workers to obtain important information on the way nitrogen compounds are utilized in plants and animals towards the production of edible protein, as in cereal, meat and milk. Encouraging results from laboratory and field experiments were reported at a Symposium on the Use of Isotopes in Studies of Nitrogen Metabolism in the Soil-Plant-Animal System, convened jointly by the Food and Agriculture Organization of the United Nations and the International Atomic Energy Agency in cooperation with the Joint Commission on Applied Radioactivity. The Symposium was held in Vienna from 28 August to 1 September 1967. Application of nuclear techniques for studies of nitrogen metabolism was discussed and cooperation between representatives of these scientific areas in order to find new ways of combatting the world protein shortage was suggested. Various applications of nuclear techniques to study fertilizer efficiency, synthesis of nitrogenous compounds in plants and their utilization by animals were described. (auth)

27487 DISTRIBUTION OF TRITIATED ECDYSONE IN SALIVARY GLANDS AND OTHER TISSUES OF RHYNCHOSCIARA AND CHIRONOMUS LARVAE. AN AUTORADIOGRAPHIC STUDY. Weirich, G.; Karlson, P. (Philipps Univ., Marburg, Ger.). Arch. Entwicklungsmech. Organ.; 164: 170-81(1969).

The distribution of tritium-labeled ecdysone in salivary glands of Chironomus tentans and different tissues of Rhynchosciara sp., was studied, following in vivo incubations, using either of two modified ethanol-acetic acid fixation techniques. The results of autoradiographic analysis show maximum label over the cytoplasm or evenly labeled cytoplasm and cell nuclei, within a wide range of incubation times. Indications of distinct localization at chromosomal loci were not conclusive. There was a remarkably high amount of radioactivity in the lumen of the anterior intestine as early as six minutes after hormone injection. The limitations of autoradiographic studies in attempts to localize the cellular receptor of ecdysone are discussed. (auth)

27488 RADIOIMMUNOASSAY. Abrahan, Guy E. (Worchester Foundation for Experimental Biology, Shrewsbury, Mass.). Pak. Med. Rev.; 3: No. 1, 22-8(Apr 1968).

The historical background, the principle, the requirements for radioimmunoassay, the factors affecting sensitivity and specificity, the methods of separation of free hormone from bound hormone, and the potential applications of radioimmunoassay are described. (Pakistan Sci. Abstr.)

27489 ISOTOPIC STUDY OF THE RHEUMATOID FACTOR. Suteanu, St.; Franchimont, P. (IMF, Bucharest). Med. Interna; 21: 181-90(1969). (In Rumanian).

The rheumatoid factor was isolated according to the method of Lospalluto and Ziff; after purification it was labeled with ^{131}I, following the method of Greenwood. After labeling, the preparation was again purified for the elimination of labeled contaminating substances. Various parameters were used for followup of the purification stages: emission of γ radiation, protein concentration, immunoelectrophoresis, and agglutination of latex particles carrying the Cohn II fraction. By making use of this labeled rheumatoid factor, an immunochemical study was used to investigate the nature and the kinetics of reaction of this factor with anti γM serum and with γG human globulin. The techniques employed for the visualization of this immunochemical reaction comprised latex agglutination, immunoprecipitation, and radioimmunoelectrophoresis. The existence of a competition between the labeled rheumatoid factor and the nonlabeled factor for the anti γM serum and for sensitized latex particles was demonstrated. The purified rheumatoid factor was used for standardization of a radioimmunological assay of the rheumatoid factor. (Excerpta Med.)

27490 RADIOIMMUNOASSAY MEASUREMENT OF LUTEINIZING HORMONE EXCRETION RATES FOLLOWING BILATERAL OOPHORECTOMY. Orr, A. Hilary; Ward, Audrey P.; Bagshawe, K. D. (Fulham Hospital, London. St. Mary's Hospital, London). J. Reprod. Fert.; 21: 207-13(1970).

The excretion of LH in a group of women subjected to bilateral oophorectomy is studied, using a radioimmunoassay method. The results are compared with those obtained by other methods and their usefulness as a basis for clinical interpretation of LH estimations by this method is discussed. (auth)

27491 LH RADIOIMMUNOASSAY IN BOVINE BLOOD SERUM. VALUES DURING THE ESTROUS CYCLE. Schams, D.; Karg, H. (Technische Hochschule, Munich). Acta Endocrinol.; 61: 96-103 (1969). (In German).

For radioimmunoassay of LH in bovine blood the preparation LER-LH-791-1 as antigen for radioiodination and the double antibody technique using filtration for separation was applied. Luteinizing hormone determinations were carried out in about 700 serum samples from five cows and one heifer during a total of 13 estrous cycles. Basic levels normally ranged between 0.4 and 2.7 ng LH/ml serum. Distinct peaks, that were represented by values between 3 and 62 ng/ml, lasted no longer than 6 hr. One peak could be demonstrated around day 8 or 9 of the cycle, another 15 to 22 hr prior to ovulation; the latter is sometimes accompanied by movements of the LH level, leading also to peaks a day before and/or after this more distinct preovulatoric peak. In some cases an extra peak occurred 3 to 6 days before ovulation. The finding of LH release twice (or more times) during the bovine cycle is in agreement with preliminary results obtained by earlier studies with the OAAD test. (Excerpta Med.)

27492 VITAMIN B_{12} DETERMINATION BY MEANS OF RADIOISOTOPE DILUTION AND ULTRAFILTRATION. Friedner, S.; Josephson, B.; Levin, K. (Central Labs., Stockholm). Clin. Chim. Acta; 24: 171-9(1969).

The vitamin B_{12} concentration in serum is determined by a new procedure, using the competition for intrinsic factor with cobalamin[^{57}Co]. The vitamin is liberated from its binding to serum protein by heating at pH 4.9 in the presence of cyanide. B_{12}[^{57}Co] and intrinsic factor are added, and the solution is ultrafiltered through a dialysis membrane. The amount of B_{12} in the sample can be calculated from the radioactivity of the ultrafiltrate compared to a standard curve. The optimal conditions and the methodological errors of each step in the procedure are examined. (Excerpta Med.)

27493 INSULIN-LIKE ACTIVITY BY FAT PAD ASSAY AND IMMUNOREACTIVE INSULIN. I. THEIR CORRELATION IN NATIVE SERUM, ACID ETHANOL EXTRACT, AND SALT ETHANOL EXTRACT. Ide, T.; Kuzuya, T.; Kajinuma, H. (Tokyo Univ.). Diabetes; 18: No. 2, 65-74(1969).

In view of controversies on the relationship of ILA (insulin like activity) and IRI (immunoreactive insulin) in blood, removal of extra factors other than insulin was attempted by means of salt ethanol (acid ethanol NaCl) or acid ethanol extraction methods prior to assay. The salt ethanol procedure, a modification of Romans method for the extraction of pancreatic insulin, proved to be more efficient in extraction. ILA was assayed by the rat fat pad method using $C^{14}O_2$ production from glucose U ^{14}C as index. IRI was assayed by a double antibody radioimmunoassay. Dog sera obtained from the pancreatic and femoral veins were chiefly used. Recoveries of endogenous IRI by salt ethanol and acid ethanol methods were 90% and 72%, respectively, which were almost identical with recoveries of insulin ^{131}I added to sera. The ILA of the extracts differed considerably from the ILA of the original sera; the recovery scattered widely between 5 and 116%. In contrast to wide discrepancies between ILA and IRA in the native sera, ILA and IRI in the extracts were much closer to each other. There was a good parallelism between regression lines of ILA in the extracts and of standard insulin, but deviation was significant between the regression lines of insulin and untreated sera. The ILA in the extracts of dog and human serum was mostly suppressed with anti insulin serum. Endogenous IRI behaves like pancreatic insulin during extraction procedure and appears to possess biological activity corresponding to its immunoreactivity. (Excerpta Med.)

27494 RADIOIMMUNOASSAY OF INSULIN IN PLASMA AND URINE IN OBESE SUBJECTS AND IN DIABETIC PATIENTS.

Jorgensen, K. R. (Steno Memorial Hospital, Gentofte, Demark). Acta Endocrinol.; 60: 719-36(1969).

By the use of the double antibody method the immunologically demonstrable insulin, both in the plasma and urine of obese subjects without clinically manifest diabetes and in diabetics who had not been treated with insulin was determined. In obese subjects without clinically manifest diabetes, hyperinsulinism was found both in the fasting state and during the glucose tolerance tests. In these subjects the 24 hr urinary excretion of insulin was significantly higher than in that of normal subjects. In obese diabetics the mean fasting plasma insulin concentration was found to be significantly higher than in normal subjects, but during oral glucose tolerance tests, despite marked hyperglycemia, the increase in the mean plasma insulin concentration was only of the same order as in that of normal subjects and had a maximum that was reached later. The 24 hr urinary excretion of insulin in obese diabetics was of the same order as in that of normal subjects. In nonobese diabetics the mean fasting plasma insulin concentration was lower than in normal subjects and lowest in the poorest regulated diabetics with high fasting blood sugar and ketonuria. During glucose tolerance tests it was not possible to demonstrate any increase in the plasma insulin concentration in the nonobese diabetics with ketonuria, while in nonobese diabetics without ketonuria a slight increase in the plasma insulin concentration was found during glucose tolerance tests. The 24 hr urinary excretion of insulin was reduced in relation to the excretion in normal subjects. Hyperinsulinism should be regarded as a characteristic of obesity per se, while the clinically manifest diabetes is always connected with hypoinsulinism in relation to body weight. (Excerpta Med.)

27495 HUMAN GROWTH HORMONE (HGH) RESPONSE TO ARGININE INFUSION TEST (AIT) IN EIGHT CASES OF PRIMARY HYPOTHYROIDISM. RADIOIMMUNOASSAY OF PLASMA HGH, THYROTROPIN (TSH), AND INSULIN. Freychet, P. (INSERM, Paris). Ann. Endocrinol. (Paris); 31: 68-79(Jan-Feb 1970). (In French).

Four out of eight women with primary hypothyroidism were poor or non-responders to the arginine infusion test (AIT). The response was clearly positive in three other subjects. During the course of thyroid therapy, response to AIT was not improved in those three patients that were poor or non-responders before therapy. The four other subjects exhibited an increased response during therapy. Initially high TSH levels were reduced in all patients given thyroid therapy. Constant reduction in plasma TSH was observed on serial sampling during AIT. Plasma insulin response to AIT was not significantly changed during replacement therapy in the subjects studied except one whose response was increased when given thyroid therapy. Results concerning HGH are discussed with respect to the clinical context in some poor or non-responders that are also obese or diabetic or both. Results are also compared to recently published data on HGH secretion in response to another stimulus, insulin hypoglycemia, in primary hypothyroidism. (auth)

27496 DESCRIPTION OF PIGMENT CHANGE IN THE WINGS OF SEASONAL DIMORPHOUS FORMS OF ARASCHNIA LEVANA-PRORSA L. (NYMPHALIDAE) AFTER ORAL APPLICATION OF ^{35}S-SODIUM SULPHATE IN THE LARVAL PHASE. Luedicke, M.; Plesse, D. (Ruprecht-Karl-Univ., Heidelberg). Z. Naturforsch.; 25b: 399-406(Apr 1970). (In German).

Sulfur-35-labeled sodium sulfate was applied orally to the larvae of Araschnia levana-prorsa. After eclosion a characteristic pattern of radioactivity could be observed on the wings of the imagines. The pigment change of Araschnia levana-prorsa caused a modification of the radioactivity pattern in the wings, which was proved by a radioautographic method. The red scale areas emitted the strongest radiation, whereas the radiation of the dark and the light areas was considerably weaker. The possibility of introducing ^{35}S into the dark and light pigment matrices, as well as the direct introduction of ^{35}S into the molecule of the red pigment Ommatin D, is discussed. (auth)

27497 TUMOR-SPECIFIC LOCALIZING AGENT FOR RADIOISOTOPE IMAGE. III. THE SYNTHESIS OF 5-IODOCYTOSINE-^{131}I AND ITS DISTRIBUTION IN TUMOR BEARING MICE. Maeda, Tatsuo (Kyushu Univ., Fukuoka); Watanabe, Isao; Kamoi, Itsuma; Kojima, Masaharu; Kudo, Keiko; Nagao, Koichiro. Radioisotopes; 19: 190-3(Apr 1970). (In Japanese).

5-Iodocytosine-^{131}I was synthesized by the exchange reaction of 5-IC with $Na^{131}I$. Specific activity of synthesized 5-^{131}IC was 450 μCi/mg (0.34 mCi/ml). The autoradiolysis was 7% in 30 days. Studies of distribution of 5-^{131}IC in mice and scintiphotography indicated that the intraperitoneally injected 5-^{131}IC was incorporated into the stomach, lung, and tumor, and excreted by the kidneys. The whole-body macroautoradiography showed the incorporation of 5-^{131}IC into the implanted tumor in mice 6 hr after intraperitoneal injection. (auth)

27498 A STUDY OF THE RADIO-IMMUNOLOGICAL DETERMINATION OF SOMATOTROPHIC HORMONE IN BENIGN AND MALIGNANT MASTOPATHIES. Gorins, A.; Netter, A.; Encha, F.; Franchimont, P. (Hopital Tenon, Paris. Hopital Necker, Paris. Institut de Medecine Julcine, Liege). Ann. Endocrinol. (Paris); 31: 59-67(Jan-Feb 1970). (In French).

The results obtained in 25 determinations of the somatotrophic hormone activity by the radioimmunological method in benign and malignant mastopathies are reported. In three cases only, the levels were quite high. In all other cases the levels were either normal or non-assessable. There was no correlation with urinary elimination of gonadotropin, estrogens, and 17-ketosteroids. It is considered possible for the somatotrophic hormone and prolactin to be completely independent of one another. But on the contrary, prolactin activity does not increase in mastopathies, a fact that makes it necessary to revise certain concepts about the role played by the hypophysis in human mammary physiopathology. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 27293, 27560, 27564, 27583, 27628, and 27702.

27499 (ANL-7615, pp 3-18) THE CONCENTRATION OF RADIUM, THORIUM, AND URANIUM BY TROPICAL ALGAE. Edgington, D. N.; Gordon, S. A.; Thommes, M. M.; Almodovar, L. R. (Argonne National Lab., Ill.).

Samples of 20 species of marine algae collected between 1961 and 1968 in Puerto Rico were analyzed for total organic material, protein nitrogen, calcium, radium, thorium, and uranium. The results suggest that the concentration of radium, thorium, or uranium by these organisms may be controlled by two mechanisms: ion-exchange or coprecipitation of the ion with the calcium carbonate matrix, or complex formation with either the protein nitrogen or some other component of the organic fraction. Concentration of radium (and possibly thorium) appears to occur by both mechanisms, the dominant one being dependent upon the division. For the Rhodophyceae and the highly calcified Chlorophyceae it is the former, and for the Phaeophycea the latter. Concentration of uranium occurs by the first mechanism. This difference in behavior is consistent with the chemical forms of the ions of these elements in seawater. (auth)

27500 (ANL-7615, pp 32-8) THE RETENTION OF ^{133}Ba IN BEAGLES. Farnham, J. E.; Rowland, R. E. (Argonne National Lab., Ill.).

Barium, like the other alkaline earths, is a bone-seeking element. These studies were designed to examine the whole-body retention and the plasma clearance of ^{133}Ba in beagles of various ages, and to compare these parameters with the values found for calcium, strontium, and radium. (auth)

27501 (ANL-7615, pp 38-43) ^{210}Pb AND ^{210}Po IN WOOD AND THE CIRCULATION OF LEAD IN TREES. Holtzman, R. B.; Ilcewicz, F. H. (Argonne National Lab., Ill.).

Measurements of ^{210}Pb and ^{210}Po concentrations in tree rings from four 100-year-old trees were made to estimate the rates of radial translocation. Decrease of the concentration of the ^{210}Pb with a 21.4-year half-life showed that there is little circulation of lead in hickory heartwood more than 20 years old. In oak there appears to be little circulation in wood less than 5 years old, but this conclusion is less reliable because of the low concentration of the ^{210}Pb and the presence of ^{226}Ra. The concentrations of the ^{210}Po correlated fairly well with those of the ^{210}Pb. Preliminary measurements of the stable lead concentrations did not show increased uptake in recent times. However, more detailed studies on the ^{210}Pb and stable lead concentrations are needed to determine the value of the heartwood of trees as a temporal record of lead contamination of the environment. (auth)

27502 (ANL-7615, pp 49-53) NON-UNIFORMITY IN THE RETENTION OF THE ALKALINE EARTHS IN ANIMALS AND MAN. Lloyd, Elizabeth (Argonne National Lab., Ill.).

In order to summarize some of the experimental information on which the model of bone turnover being developed for the ICRP must be based, measurements of the uptake and loss of ^{45}Ca, ^{89}Sr, and ^{226}Ra in bones and in parts of bone of rabbits, dogs, and man are reviewed. (auth)

27503 (ANL-7615, pp 56-8) NATURAL THORIUM IN HUMAN BONE. Lucas, H. F. Jr.; Edgington, D. N.; Markun, Frank (Argonne National Lab., Ill.).

The ^{232}Th concentration in rib bone from 38 humans ranged from <0.1 to 72 ng/g ash. Values increased with age and were

fitted by the expression $Y = (0.16 \pm 0.02)T$, where Y is the ^{232}Th concentration in ng/g bone ash and T is the age in years. Evaluation of retention of the ^{228}Ra produced by decay of ^{232}Th is not feasible because direct intake of naturally occurring ^{228}Ra is too large. (auth)

27504 (ANL-7615, pp 58-76) A MODEL FOR THE REMODELING AND EXCHANGE RATE DISTRIBUTIONS IN ADULT HUMAN BONE. Preliminary Report. Marshall, J. H. (Argonne National Lab., Ill.).

The International Commission of Radiological Protection (ICRP) has requested information concerning the turnover times of bone-seeking radioisotopes in different kinds of human bone tissue. Maximum permissible doses to bone were heretofore calculated assuming a uniform distribution. ICRP would now like to calculate doses separately for cortical and trabecular bone, for bone volumes, and for bone surfaces. The following model is being developed in order to organize what experimental data are available and to provide such information. It represents an extension of the power function model and takes explicitly into account the microscopic mechanisms of tracer deposition and removal. (auth)

27505 (ANL-7615, pp 97-115) METABOLISM OF ^{232}Th DECAY SERIES RADIONUCLIDES IN MAN AND OTHER ANIMALS FOLLOWING INTRAVASCULAR ADMINISTRATION OF THOROTRAST. Parr, R. M.; Lucas, H. F. Jr.; Griem, M. L. (Argonne National Lab., Ill.).

The activities of ^{232}Th decay series radionuclides were studied in tissue samples from six human patients and nine experimental animals to whom Thorotrast was administered intravascularly. In favorable cases where analyses could be commenced before extensive in vitro radioactive growth or decay had occurred, the in vivo activities of seven nuclides, ^{232}Th, ^{228}Ra, ^{228}Ac, ^{228}Th, ^{224}Ra, ^{212}Pb, and ^{212}Bi, were determined. The available information on the translocation of these nuclides within the body is reviewed, and current best-estimates are derived for the distribution of activities and consequent dose rates in the tissues of typical long-term Thorotrast patients. The anomalous behavior of ^{228}Ra, which is retained in the reticuloendothelial system in high concentrations, is explained by a model that postulates that atoms are trapped within the Thorotrast particles unless the recoil distance through which they move at the moment of their creation is sufficient to allow their escape. (auth)

27506 (CONF-690540-, pp 298-308) Y-Sr ACTIVITY RATIO IN THE SKELETONS OF RATS. Steinbach, K. H.; Weber, E.; Giss, M. (Institut fuer Experimentelle Biologie, Heilingenberg (West Germany)). (In German).

In the femurs of rats, the ratio of strontium to yttrium was determined with respect to age, sex, and time lapse between incorporation and measurement. $^{90}Sr-^{90}Y$ in equilibrium was administered to the animals and from two separate measurements of the bone samples the activity ratio was determined. Since the basic structural element of bone is the apatite crystal, and since the ion radii of yttrium and calcium closely agree while that of strontium is much larger, yttrium was found to be retained preferentially. (H.B.G.)

27507 (CONF-690540-, pp 309-20) ACTIVITY AND DOSE DISTRIBUTIONS ON INCORPORATION OF ^{224}Ra(ThX) IN ANIMAL EXPERIMENTS. Mueller, Walter A. (Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Biologie). (In German).

Radium-224 was administered intraperitoneally to mice and rats. From the decay products, ^{212}Pb was used for measurement and its 238 keV γ-emission was determined with a scintillation counter. Urinary and fecal excretion, whole-body content, and organ distribution were analyzed. Fecal excretion was approximately ten times higher than urinary excretion. Five days after injection, excretion became negligible. The remainder was predominantly retained in bone and kidney. LD_{50} was 150 μCi/kg for mice and 30 μCi/kg for rats. Induction of osteosarcomas was observed in both species even after administration of the smallest dose of 5 μCi/kg. (H.B.G.)

27508 (CONF-690540-, pp 321-8) FIBROSIS OF THE LUNGS IN EXTRAPULMONARY THOROTRAST DEPOSITS. Grueter, H.; Backmann, R. (Muenster Univ. (West Germany)). (In German).

Three autopsies were performed on patients who received Thorotrast for angiographic purposes. The diagnostic procedures were performed 20 to 30 yr prior to autopsy. Severe fibrosis of the lungs was found in all three patients. Chemical determination of ^{232}Th was possible in two patients and showed 4.3 and 6.6 g respectively for liver and spleen together. The total dose received by the pulmonary tissues was calculated. Values of 660 and 1500 rem were found. These figures must be considered as conservative because the ^{232}Th of bone and bone marrow was not determined. It was concluded that the pulmonary fibrosis was the result of radiation damage caused by the daughter products of ^{232}Th. (H.B.G.)

27509 (CONF-691001-, pp 103-19) MODELS FOR THE STUDY OF PARTICLE RETENTION AND ELIMINATION IN THE LUNG. Morrow, P. E. (Rochester Univ., N. Y. Dept. of Radiation Biology).

The direct or inferred relation between appropriate measurements of aerosols or gases and inhalation risk has been the basis for most of environmental hygiene and health physics practice in the assessment of airborne hazards. A modern extension of this concept is the design and application of lung models for the purpose of developing more realistic evaluation procedures, which, moreover, can utilize variations in environmental conditions to affect changes in risk estimations. Examples are the several tracheobronchial models expressly designed for radon daughter dosimetry and the Lung Dynamics Task Group (ICRP) model proposed for radioactive aerosols generally. This presentation briefly reviews particulate deposition information as an introduction to the main topic, the elimination of nongaseous materials from the respiratory system. The models discussed are the amended ICRP Committee 2-lung model, a new kinetic description for tracheobronchial clearance, and a new conceptual basis for generalizing particulate elimination from the lung parenchyma. The mechanisms and pathways underlying these models provide cogent information for understanding lung responses to environmental contaminants even when simple dose-effect relations are not available or applicable. (auth)

27510 BIOLOGICAL RESPONSE TO SMALL DISCRETE HIGHLY RADIOACTIVE SOURCES. II. MORPHOGENESIS OF MICROLESIONS IN RAT LUNGS FROM INTRAVENOUSLY INJECTED $^{238}PuO_2$ IN MICROSPHERES. Richmond, C. R.; Langham, J.; Stone, R. S. (Los Alamos Scientific Lab., N. Mex.). Health Phys.; 18: 401-8(Apr 1970).

Evaluation of risk from high specific-activity particulate nuclear fuels, being used in thermoelectric generators, by the organ-mean dose concept seems dubious. A maximum permissible lung burden may consist of a single or at most a few particles from which all the energy is deposited in very small tissue volumes. This paper presents the progressive gross and histological development of microlesions produced in rat lung tissue from highly radioactive ($\sim 10^8$ and $\sim 10^3$ rads/hr surface dose for α and x-rays, respectively) microspheres injected into the femoral vein and lodged in the lung vasculature. Histological sections were prepared from animals killed on days 1, 3, 7, 14, 21 and 28 and at monthly intervals for the following 6 months. Cellular changes were apparent as early as 24 hr. The microlesion, characterized by concentric regions of cellular debris and collagenous tissue surrounding the microsphere, became more complex with time but appeared to be self-limiting. Curiously, some cells in areas receiving 10,000 to 100,000 rads over 3 days appeared viable. No alterations were seen in control rats given tungsten carbide spheres. (auth) (UK)

27511 RESULTS OF THE WHOLE-BODY COUNTING OF PATIENTS WITH KNOWN AMOUNT OF INJECTED THOROTRAST. Malatova, I.; Drorak, V. (Inst. of Radiation Hygiene, Prague). Health Phys.; 18: 431-2(Apr 1970).

Results are reported of whole body counting in relation to the amount of injected thorotrast only in patients without paravasal deposits. Errors in the measurements of ^{208}Tl were less than 5% and of ^{228}Ac less than 10%. The average activity ratio of ^{228}Ac as measured in vivo to ^{232}Th in thorotrast injected was 0.33. The average ratio of whole-body activities was found to be $^{212}Bi/^{228}Ac = 0.69$. (UK)

27512 SOME ASPECTS OF PHENYLALANINE INCORPORATION IN DEUTERIUM OXIDE (D_2O) SUBSTITUTION FOR WATER (H_2O) IN POLYURIDYLIC ACID-DIRECTED RIBOSOMAL PROTEIN BIOSYNTHESIS. Lewin, S.; Williams, B. A.; Potter, B. J. (North-East London Polytechnic). Biochem. J.; 117: 20p(Apr 1970).

It has been shown by many workers that D_2O substitution for H_2O can result in significant effects on biological processes both in vivo and in enzymic activities in vitro. Work is described concerning certain facets of the incorporation of phenylalanine in polyuridylic acid-directed ribosomal protein biosynthesis. Increasing concentrations of D_2O up to 60% enhanced phenylalanine uptake. However when freshly prepared S.30 fractions were used a maximum enhancement of phenylalanine incorporation appeared in the region of 15 to 20% D_2O. (UK)

27513 SEMI-EMPIRICAL MODEL FOR RADIONUCLIDE TRANSPORT IN MAMMALS. Bonta, W. K. (Isotopes, Inc.; Middle River, Md.). Contract AT(29-2)-2062. Health Phys.; 18: 389-400(Apr 1970).

Complicated exposure situations are often encountered when performing a theoretical hazards analysis. It is often required to piece together smaller models of less complicated animal experiments such that dose computations may be performed for these hypothetical exposures. Since experimentalists have encountered dissimilarities in tissue distribution when changing the modes of dose administration, this model coupling procedure was considered unwise. An attempt was made to develop a method that would identify those mechanisms that affect these route of entry difficulties. This method was used during a system hazard analysis on a ^{210}Po fueled thermoelectric generator. The method uncovered the possibility that physiological mechanisms in respiratory lymph node and liver metabolism have not been treated in the existing models. The method did not reveal any inconsistencies in critical organ distribution and retention. Therefore this study supported the procedure of coupling together the simpler models for calculating doses to the critical organs from ^{210}Po. (auth) (UK)

27514 ^{75}Se-SELENOMETHIONINE IN THE STUDY OF PROTEIN AND AMINO ACID METABOLISM OF ADULT RATS. Said, A. K.; Hegsted, D. M. (Havard School of Public Health, Boston). Proc. Soc. Exp. Biol. Med.; 133: 1388-91(Apr 1970).

There is abundant evidence that selenomethionine is an analogue of methionine. Whole-body counting of ^{75}Se after the administration of ^{75}Se-selenomethionine was used to determine whether this technique might be used to evaluate overall changes in protein metabolism in animals fed different amounts of protein or methionine. Changes in overall body counts were not sensitive to changes in these dietary variables, but the excretion of ^{75}Se was greatly affected by the selenium content of the diet. Thus, whole-body counting is apparently not a useful technique for following the metabolism of tissue proteins. (auth)

27515 EFFECTS OF SODIUM ALGINATE AND OTHER UNTESTED POLYMERS ON RADIOSTRONTIUM RETENTION IN THE RAT. Light, James M.; Stookey, George K.; Muhler, Joseph C. (Indiana Univ., Indianapolis). Proc. Soc. Exp. Biol. Med.; 133: 1259-64(Apr 1970).

At levels of 1, 5, and 10%, sodium alginate, guar gum, carboxymethyl guar gum, and Questran were tested in diets fed to rats to determine their effects on skeletal retention of ^{45}Ca and ^{89}Sr. Alginate was the only effective agent against radiostrontium retention, approaching, at the 10% level, 70% less ^{89}Sr skeletally retained than in control animals and a 3-fold improvement over natural biological strontium–calcium discrimination. The strontium-binding ability shown by alginate was probably due to its functional carboxyl groups. (auth)

27516 EFFECTS OF URANIUM ON THE GROWTH AND DEVELOPMENT OF PLANTS AND ITS ACCUMULATION AS A FUNCTION OF THE CONTENT IN THE GERMINATION MEDIUM. Prister, B. S.; Prister, S. S. Radiobiologiya; 10: 138-40(Jan-Feb 1970). (In Russian).

It was found in greenhouse experiments that U at a dose of 200 mg/kg of sand was nontoxic for plants. For a water culture a 50 mg/liter dose of U results in death of corn plants on the fourth day. The relation between the accumulation of U by the plants and its content in the medium was a decreasing exponential function. With increasing U concentration in the roots, intake into the aboveground portion of the plants decreased. (tr-auth)

27517 ^{90}Sr, STRONTIUM, AND CALCIUM IN CERTAIN HYDROBIONTS OF THE SEA OF OKHOTSK. Kostareva, G. V.; Bachurin, A. A.; Sokolova, N. V. (Inst. of Biology, Sevastopol, USSR. Pacific Ocean Scientific Research Inst. of Fishing and Oceanography, Magadan, USSR). Radiobiologiya; 10: 145-7 (Jan-Feb 1970). (In Russian).

The concentration of ^{90}Sr, as well as the content and coefficients of accumulation of Sr and Ca in certain species of seals and fish of the Sea of Okhotsk were determined. A comparison with the literature data indicated that the concentrations of ^{90}Sr in the investigated hydrobionts are comparable with those for fish of the Indian and Atlantic Oceans and for seals of the Chukochi Sea. The coefficients of discrimination of Sr with respect to Ca in fish from different seas were the same. The Sr concentrations, as well as Ca in related species of fish from seas with different salt contents proved close. (tr-auth)

27518 ON THE QUESTION OF THE EXISTENCE OF A PLACENTAL BARRIER TO ^{137}Cs. Baklanova, S. M.; Burovina, I. V.; Leont'ev, V. G.; Skul'skii, A. (Inst. of Evolutionary Physiology and Biochemistry, Leningrad). Radiobiologiya; 10: 141-4(Jan-Feb 1970). (In Russian).

In an investigation of the distribution of natural concentrations of the alkali elements in the tissues of white rats and guinea pigs at various periods of postnatal development, it was shown that the factor determining the nature of this process was the ionic selectivity of the tissues. The differences in the ionic composition of the alkali elements in the tissues of newborn and adult animals depended on the degree of their functional maturity. The ionoselective properties of the tissues and peculiarities of ontogenetic development of the organism determined the distribution of cesium-137 and stable cesium between the parent organism and the fetus. (tr-auth)

27519 CALCIUM METABOLISM AND GROWTH RATE OF RATS. Bohr, H. (Orthopedic Hospital, Copenhagen). Calcified Tissue Res., Suppl.; 2: 68(1968).

The uptake of radiocalcium in the skeleton is attributable mainly to new bone formation; the uptake in bones of rats diminishes rapidly from 3 to 6 month old animals and then decreases only slowly with age according to the growth rate, measured by repeated labelings with tetracycline. (Excerpta Med.)

27520 EFFECT OF NITROGEN ON ^{137}Cs IN SOILS AND ITS UPTAKE BY OAT PLANTS. Evans, E. J.; Dekker, A. J. (Canada Dept. of Agriculture, Ottawa). Can. J. Soil Sci.; 49: 349-55(Oct 1969).

The effects of time of addition of NH_4 relative to ^{137}Cs and of NH_4 compared with NO_3 were studied. The results showed conclusively that NH_4 caused higher ^{137}Cs concentrations in oats than did the NO_3 form of N at low soil K contents. The results were less conclusive for soils to which K had been applied. When NH_4 was applied before ^{137}Cs, in most instances the ^{137}Cs concentration was higher than when Cs was applied before NH_4 without added K. When K was added, however, the trends were for the most part the reverse. Thus NH_4, K and ^{137}Cs in the soil interact for sites on the soil exchange complex and the amount of ^{137}Cs taken up by the plant is a function of this interaction. Liming of one acid soil consistently increased the ^{137}Cs concentration and uptake, whereas in another acid soil the effects of liming were less consistent. (auth)

27521 DEPRESSED METABOLISM. Proceedings of the First International Conference, Washington, D. C., August 22-23, 1968. Musacchia, X. J.; Saunders, Joseph F. (eds.). New York; American Elsevier Publishing Company, Inc. (1969). 648p. $16.00. (CONF-680847).

A separate abstract was prepared on one paper. Fourteen additional papers report the results of research on depressed metabolism in mammalian systems. (C.H.)

For an abstract of one paper see: 27702.

Radiation Effects

Refer also to abstracts 27569, 27617, 27662, and 28676.

27522 (CONF-690540–, pp 13-21) PRINCIPLES OF BIOLOGICAL RADIATION EFFECTS. Pauly, H. (Erlangen-Nuernberg Univ. (West Germany). Institut fuer Physikalische und Medizinische Strahlenkunde). (In German).

Doses in the Mrad range are required for deactivation of enzymes because of their radioresistance. Similarly, cell respiration, glycolysis, and membrane permeability show extraordinary radioresistance. In sharp contrast, cell division is highly sensitive to ionizing radiation. Cultures of any mammalian cell exposed to about 1000 rad show definite impairment. Although the cells continue to grow, their division proceeds in an irregular manner and, not infrequently, produces pathologic giant cells that exceed normal size by a factor of 100. Radiation effects on various enzymes and tissue cultures are depicted in six graphs. (H.B.G.)

27523 (LIB/Trans-249) INFLUENCE OF THE CULTURE TIME ON THE IRRADIATION INDUCED CHROMOSOME ABERRATIONS OF HUMAN LYMPHOCYTES OF THE PERIPHERAL BLOOD. Golob, Erich; Fischer, Patricia; Kunze-Muhl, Elfriede. Translated by J. B. Hopkinson (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Strahlentherapie; 137: 63-7(Jan 1969). 9p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original language, appeared as NSA 23: 29455.

27524 EFFECT OF IONIZING RADIATION AND RADIOMIMETICS ON THE LEVEL OF STRONGLY BOUND LIVER PHOSPHOLIPIDS IN ANIMALS. Shostakovskaya, I. V.; Goyda, E. A. (Lvov State Univ.). Biol. Deistvie Radiats., Lvov. Gos. Univ.; No. 4, 80-4(Sep 1969). (In Russian).

Chinchilla rabbits weighing 2 to 2.95 kg were exposed to whole-body irradiation with a dose of 800 rads, and male random-bred rats weighing 150 to 180 g to 700 or 1,500 rad at dose rates of 50

to 200 rad/min. Two hours, 1, 2, 3, and 4 days after exposure, the content of strongly bound phospholipids (P) was determined in the liver. Within two hours of exposure to 600 R, the rats exhibited a 44 to 56% increase in P content, which was followed by a progressive decrease in 1 to 3 days. On the 4th day there was a further increase, but it did not reach the control level. In the liver of rats irradiated with 1,500 rad, the P level rose by 82 to 112% after 2 hours and by 4 to 26% after 24 hours, progressively dropping thereafter. Similar phase changes in the P level were noted in the liver of rabbits irradiated with 800 rad. In other experiments, rats were injected intraperitoneally with 0.4 to 0.6 ml of a lipid radiotoxin (LR) or 0.12 to 0.18 ml/100 g body weight of oleic acid (OA) as a model of LR. The P level rose by 20 to 30% 2 hours after the substances were injected. A slight drop in the P level occurred 1 and 2 days after injection of OA, but there was a 35 to 45% rise one day after injection of LR followed by a sharp drop on the 2nd day. The P content of the liver was 22 to 34% below the control level three and four days after injection of LR and OA. It was concluded (from the similarity in the general nature of the changes in P content of the liver) that the effect of irradiation and the radiomimetics tested (LR and OA) is based on the same mechanism. It was also concluded that the development of radiation injury is due to the formation of radiotoxins. (JPRS)

27525 CHANGE IN THE AMINO-ACID COMPOSITION OF BLOOD SERUM IN BETATRON-IRRADIATED RABBITS. Petrus, V. S.; Bessonova, G. S. (Lvov Univ.). Biol. Deistvie Radiats., Lvov. Gos. Univ.; No. 9, 70-5(Sep 1969). (In Russian).

Twenty-five rabbits weighing 2.3 to 3 kg were exposed to whole-body γ irradiation with a dose of 300 R. The free amino acids (FA) were determined in serum by paper chromatography 6, 24, and 72 hr after exposure. After 6 hours the FA level rose considerably, except for leucine and valine + methionine, whose content decreased and remained low thereafter. Specifically, the cystine content rose from the normal 2.71 to 4.09 mg %, falling after 24 and 72 hours to 2.13 and 1.72 mg %, respectively. The levels of the other FA in serum 72 hours after irradiation were quite high. For example, the content of serine + aspartic acid rose from 3.52 to 5.04 mg %; that of cystidine, from 1.34 to 3.68 mg %. Three days after irradiation, 25 rabbits were inoculated with bivalent typhoid and paratyphoid B vaccine in doses of 0.25, 0.50, and 1.0 ml at 1-week intervals. The FA were determined in serum weekly for 7 weeks. The content of leucine, phenylalanine, valine + methionine, cystine, alanine, glycine, and histidine in the FA was more variable in the experimental rabbits than in controls, with the same direction of changes, but the content of threonine + glutamic acid, serine + aspartic acid, and histidine changed in the opposite direction. (JPRS)

27526 THERAPEUTIC AGENTS WHICH MODIFY THE STRUCTURAL STABILITY OF THE MACROMOLECULES OF THE CONNECTIVE TISSUE. Velican, C. (Institutul de Medicina Interna N. Gh. Lupu, Bucharest). Med. Interna; 21: 771-80(Jul 1969). (In Rumanian).

Investigations of alterations of the stability of macromolecules in the pathogenesis of internal diseases are reported. Data from the literature are presented on the effects of substances with antiinflammatory activity, vitamins, and ionizing radiation on the stability of macromolecules from the connective tissue. (auth)

27527 TRYPSIN ESTERASE BINDING AND ITS RELATION TO THE RADIATION-LEUKEMIA PROTECTION (RLP) FACTOR. Yip, Lily C.; Hodes, M. E. (Indiana Univ., Indianapolis). Contract AT(11-1)-1391. Proc. Soc. Exp. Biol. Med.; 133: 1285-8 (Apr 1970).

Methods for determining trypsin esterase binding activity and trypsin inhibiting capacity are described. Graphs are presented to show trypsin esterase binding activity in relation to gel filtration of sheep serum and spleen on Sephadex G-200. The trypsin inhibiting capacity of sheep serum was present in most of the Sephadex G-200 fractions. After exposure of mice to 300 R x radiation, the trypsin esterase binding activity of their serum decreased and remained depressed for several days. Injection of sheep serum, but not saline or albumin, restored the trypsin esterase binding activity. The relationship of the radiation leukemia protection activity of spleen and serum to a 2-macroglobulin is discussed. (H.L.W.)

27528 SERUM INTESTINAL ALKALINE PHOSPHATASE IN RATS AFTER 800 R WHOLE-BODY OR REGIONAL X-IRRADIATION. Highman, Benjamin; Hanks, Alan R. (Armed Forces Inst. of Pathology, Washington, D. C. National Inst. of Health, Bethesda, Md.). Proc. Soc. Exp. Biol. Med.; 133: 1201-6(Apr 1970).

To determine if the fall in serum alkaline phosphatase (SAP) in rats after whole-body or abdominal x-irradiation was due largely to decreased ability to produce intestinal alkaline phosphatase (IAP), young adult male Sprague–Dawley rats were exposed to 800 R whole-body or regional irradiation. Determinations were made of SAP with or without the addition of L-phenylalanine. The reduction in value of SAP by this inhibitor was used to indicate the relative amount of IAP contributed to the serum. Administration of olive oil by stomach tube, which stimulates production of IAP, caused a sharp rise in the L-phenylalanine-inhibited fraction of SAP in normal starved rats, but virtually no rise 4 days after whole-body or abdominal irradiation. Shielding the abdomen or its upper or middle portions during irradiation gave fairly complete protection and permitted a normal response to olive oil, while shielding the lower abdomen or duodenum gave only slight to moderate protection. Irradiating the entire abdomen or the midportion gave the same effect as whole-body irradiation, while irradiating the upper or the lower abdomen or duodenum caused a moderate suppression of the normal response to olive oil. These findings indicate that injury to the duodenum and jejunal mucosa is mainly responsible for the fall in IAP in the serum following irradiation and that the injury is sufficient to diminish or prevent synthesis of intestinal alkaline phosphatase even after stimulation by olive oil. This appears to be caused by a reduced population of differentiated cells lining the villi. (auth)

27529 INFLUENCE OF ULTRAVIOLET RAYS ON DNA BIOSYNTHESIS IN THE EPIDERMIS. Bogutskii, B. V.; Koval'chuk, S. I. (Scientific Research Inst. of Physical Methods of Therapy and Medical Climatology, Yalta, USSR). Radiobiologiya; 10: 25-7(Jan-Feb 1970). (In Russian).

The influence of various doses of ultraviolet rays on DNA biosynthesis in the cells of irradiated mouse epidermis at various periods of time after irradiation was investigated. A great sensitivity of DNA synthesis to ultraviolet irradiation was demonstrated. The reaction was characterized by phase changes in the synthetic process: depression and activation. Doses of irradiation twice as great as the erythema dose or more produced a more or less pronounced block of DNA synthesis in the irradiated epidermis. (tr-auth)

27530 INDUCED ENZYMES AND IONIZING RADIATION COMMUNICATION I. CHANGE IN THE TRYPTOPHAN PYRROLASE ACTIVITY IN RATS AFTER IRRADIATION. Popov, P. G.; Ankov, V. K. (Higher Military-Medical Academy, Sofia). Radiobiologiya; 10: 32-6(Jan-Feb 1970). (In Russian).

X irradiation of the entire body of an animal produced a wave-shaped curve, reflecting the activity of tryptophan pyrrolase (oxygenase), with a two-fold increase after 4 hr, a drop almost to the normal level by the 27th hr, and another 2.5-fold increase by the 72nd hr. The observed increase was chiefly due to an increase in the amount of the apoenzyme, i.e., to new synthesis of the enzyme. The synthesis of the apoenzyme was not disturbed up to 1800 R and was inhibited at 5000 R by approximately 25% in comparison with that at 1800 R. The activating ability of the microsomes did not undergo any significant changes. (tr-auth)

27531 CYTOCHEMISTRY OF SUCCINATE DEHYDROGENASE IN CERTAIN PORTIONS OF THE MOUSE BRAIN AFTER TOTAL X-IRRADIATION. Palashchenko, L. D.; Potemkina, S. D. (Vladivostok Medical Inst., USSR). Radiobiologiya; 10: 28-31 (Jan-Feb 1970). (In Russian).

The succinate dehydrogenase activity in the neutrons of the cerebral cortex, cerebellum, and medula oblongata was investigated at the level of the open rhomboid fossa after irradiation of mice at a dose of 600 R. Change in enzyme activity with time and variations in neuron radiosensitivity were detected. The greatest radiosensitivity was possessed by the nuclei of the medulla oblongata, followed by the nerve cells of the cerebral cortex. The neurons of the cerebellum were least radiosensitive. (tr-auth)

27532 EFFECTS OF GAMMA-RADIATION ON THE RESPIRATION OF THYMOCYTE NUCLEI. Kuzin, A. M.; Tarshis, M. A. (Inst. of Biophysics, Pushchino, USSR). Radiobiologiya; 10: 116-19(Jan-Feb 1970). (In Russian).

The respiration of thymocyte nuclei after their irradiation in vivo and in vitro was investigated. After 30 min an 18.04% stimulation of respiration was observed in the nuclei isolated from irradiated animals, after 1 hr a gradual inhibition of respiration, reaching 17.76% after 2 hr, and after 4 hr a 44.09% inhibition. The nuclei irradiated in vitro lost their ability to take up oxygen considerably more rapidly and to a greater degree. Irradiation and incubation of nuclei in a solution of blood serum substantially lowered the degree of radiation damage to respiration. It is proposed that radiation impairment of nuclear respiration occurs chiefly on account of an increase in the permeability of the nuclear membranes as a

result of their damage by active radicals from the external medium. (tr-auth)

27533 DEPENDENCE OF THE EXCRETION OF DEOXYURIDINE, THYMIDINE, AND BETA-AMINOISOBUTYRIC ACID BY RATS ON THE DOSE OF IRRADIATION AND TIME AFTER WHOLE-BODY RADIATION INFLUENCE. Mazurik, V. K.; Bryksina, L. E.; Bibikhin, L. N. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 10: 43-8(Jan-Feb 1970). (In Russian).

On the first day after irradiation, the excretion of deoxyuridine and thymidine by rats was a linear function of the dose in the range from 50 to 500 to 700 R and was equally great at higher levels of radiation; the excretion of β-aminoisobutyric acid did not depend on the dose. The amount of post-radiation hyperexcretion of thymidine was inversely proportional to the logarithm of the weight of the animals and was closely correlated with the postradiation decrease in the DNA content in the spleen and thymus. A mathematical description of the dependence of the excretion of thymidine on the weight of the rats and dose of whole-body irradiation is given. Two (dose 50 to 300 R) or three (dose more than 400 R) waves of hyperexcretion of deoxynucleosides were detected over a period of 30 days after irradiation. (tr-auth)

27534 INVESTIGATION OF RNA SYNTHESIS IN THE WHITE RAT LIVER AND SPLEEN AT THE EARLY STAGES OF ACUTE RADIATION SICKNESS. Paskevich, I. F.; Vasil'eva, E. S.; Todorov, I. N.; Shantyr, V. I. (Scientific Research Inst. of Medical Radiology, Kharkov. Inst. of Radiophysics and Electronics, Kharkov). Radiobiologiya; 10: 19-24(Jan-Feb 1970). (In Russian).

At the early stages of acute radiation sickness, a substantial activation of mRNA biosynthesis was observed in the liver along with a substantial suppression in the spleen; moreover, these changes were most pronounced 2 hr after irradiation; by the end of a 24-hr period, a tendency for normalization of these indexes was observed. The changes in the biosynthesis of other types of RNA under these conditions were not so pronounced. Possible causes of the indicated changes are considered. (tr-auth)

27535 SOME EXPERIMENTAL DATA ON THE CHANGE IN GAS EXCHANGE OF WHITE RATS UNDER THE INFLUENCE OF IONIZING RADIATION. Chulkova, O. N. (Scientific Research Inst. of Radiation Hygiene, Leningrad). Radiobiologiya; 10: 74-7 (Jan-Feb 1970). (In Russian).

An increase in the gas exchange on the 7th and 15th days of treatment of white rats with a mixture of radioisotopes (initial activity of 15 μCi) was noted. During a year and a half, the elimination of the absorbed dose reached 700 rad; moreover, no change in the gas exchange at rest was observed. After external x irradiation at a dose of 300 R there was an inhibition of gas exchange on the 6th and 15th days. The combined action of x irradiation and the introduction of low concentrations of a mixture of radioisotopes into the gastrointestinal tract did not differ from the effect of irradiation alone on the gas exchange. (tr-auth)

27536 REDUCTION OF THE YIELD OF DNA IN THE DEPROTEINIZATION OF UV- OR gamma-IRRADIATED SOLUTIONS OF DEOXYRIBONUCLEOPROTEIN. I. DEPENDENCE OF THE MAGNITUDE OF THE EFFECT ON THE COMPLETENESS OF THE COMPLEXATION OF DNA WITH PROTEIN. Sklobovskaya, M. V.; Ryabchenko, N. N. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 10: 14-18(Jan-Feb 1970). (In Russian).

In the deproteinization of deoxyribonucleoprotein (DNP) solutions or artificial complexes of DNA with protein, irradiated by uv light at doses of 10^5 to 10^6 erg/mm^2 or by ^{60}Co γ rays at doses of 10 to 100 kR, a dose-dependent decrease in the yield of DNA was observed. The magnitude of this effect depended on the completeness of the complexation of the DNA and protein. (tr-auth)

27537 CHANGE IN THE PERMEABILITY OF NUCLEOPROTEIN MONOLAYERS UNDER THE ACTION OF X RAYS. Tongur, A. M.; Pavlovskaya, T. E.; Nikulin, Yu. P. (Inst. of Biochemistry, Moscow). Radiobiologiya; 10: 9-13(Jan-Feb 1970). (In Russian).

The effects of x rays on the permeability of monolayer barriers of deoxyribonucleoprotein (DNP), separating the enzyme and substrate in the oxidation of methylene blue by peroxidase, are cited. It was shown that monolayer interfaces of DNP possess substantial radiosensitivity. Monolayers produced from preliminarily irradiated solutions of DNP undergo permeability changes at substantially higher doses of irradiation and to a smaller extent. (tr-auth)

27538 INFLUENCE OF IONIZING RADIATION ON THE INCORPORATION OF ^{32}P INTO THE PROTEINS OF CALCIFIED TISSUES OF AUGUST RATS. Prokhonchukov, A. A. (Central Scientific Research Inst. of Stomatology, Moscow). Radiobiologiya; 10: 108-11(Jan-Feb 1970). (In Russian).

It was established in experiments on 40 rats of the August line that the action of x rays at a dose of 500 R produced a sharp decrease in the incorporation of ^{32}P into the proteins of calcified tissues, especially of the femur. The reduction of the level of incorporation of ^{32}P is considered as an index of impairment of the processes of binding of phosphates by proteins, which is evidence of a disturbance of the chemical bond between the collagen of the protein matrices and hydroxyapatite crystals of the calcified tissues. The role of disturbances of the ability of proteins to bind phosphates in the pathogenesis of radiation damages to calcified tissues is discussed. (tr-auth)

27539 COMPARATIVE EFFECTS OF HIGH-ENERGY RADIATION OF A 25-MeV BETATRON AND ^{60}Co ON THE FUNCTIONAL STATE OF CERTAIN GLANDS OF INTERNAL SECRETION. Pegel, V. A.; Dokshina, G. A.; Potapova, A. I. (Tomsk Univ., USSR). Radiobiologiya; 10: 49-53(Jan-Feb 1970). (In Russian).

Results of irradiation of rats with a 25 MeV betatron and with ^{60}Co at an equivalent dose of 1000 rad are presented for the change in the content of adrenaline-like substances in the blood and urine, 11-hydroxycorticosteroids, insulin-like activity of the plasma, and 17-hydroxycorticosteroids of the urine, as well as the liver sugar and glycogen. Data on the high RBE for betatron bremsstrahlung were obtained. The more significant effect obtained in the accelerator-irradiated animals is attributed to the larger absorbed dose created in the organs and tissues. (tr-auth)

27540 SUCCINATE DEHYDROGENASE ACTIVITY IN CERTAIN TISSUES OF ANIMALS UNDER THE ACTION OF PENETRATING RADIATION. Satkhozhina, E. A.; Chteshev, A. B. (Inst. of Biological Physics, Pushchino, USSR. Inst. of Experimental Biology, Alma-Ata, SSR). Radiobiologiya; 10: 105-8(Jan-Feb 1970). (In Russian).

The succinate dehydrogenase activity in the brain, cardiac muscle, kidneys, liver, lungs, and spleen of animals was studied 6, 12, 24, and 48 hr after total x irradiation at a dose of 900 R. It was shown that the inhibition of the activity of this enzyme in the brain, heart, kidneys, and lungs of rats occurred after 12 hr and was normalized on the second day of radiation sickness, whereas these disorders, detectable after 6 hrs in guinea pigs, reached a maximum 48 hr after the influence of radiation. (tr-auth)

27541 INFLUENCE OF IONIZING RADIATION ON THE CONTENT OF HISTONES AND DNA IN THE NUCLEI OF PLANT CELLS. Kuzin, A. M.; Mal'tsev, A. V.; Seisebaev, A. (Inst. of Biophysics, Pushchino, USSR). Radiobiologiya; 10: 103-5 (Jan-Feb 1970). (In Russian).

The content of histones and DNA in the nuclei of meristem cells of plants differing in radiosensitivity after γ irradiation was investigated by the method of cytophotometry. It was shown that the amount of DNA in the nuclei at stimulating doses did not differ from the content in the control, whereas the amount of histones was reduced by ~9%. At lethal doses of irradiation there was a substantial decrease in the content of histones (~20%) and DNA (~15%). (tr-auth)

27542 ALTERATIONS IN THE ACTIVITY OF l GLUTAMATE NAD OXIDOREDUCTASE UNDER THE INFLUENCE OF IONIZING RADIATIONS AND IN TUMORS. Trandafirescu, M.; Iancu, I.; Ionescu, M. (IMF, Iasi). Oncol. Radiol.; 8: No. 1, 37-42(1969). (In Rumanian).

Changes in the activity of l-glutamate oxidoreductase, as well as the factors that might influence its activity, were followed up in the irradiated liver of Guerin tumor-bearing rats, in the normal human skin and in epitheliomas. An increase in the activity of this enzyme of approximately 20%, was found in the liver of tumor bearing rats. In the irradiated animals, the activity of the enzyme fell by about 10%. The Zn^{++} inhibition constant of this enzyme differed in the tumor bearing animals from that in the other groups. At a concentration of 1.75×10^{-4} M $ZnSO_4$ up to 2.45×10^{-4} M $ZnSO_4$ enzyme in normal tissue, liver, or skin is completely inhibited. The enzyme in the liver of tumor-bearing animals and in epithiliomas remains active. Inhibition with Zn^{++} was reversible with cysteine in all the cases studied, but not with glutathione. (Excerpta Med.)

27543 EFFECT OF IRRADIATION TEMPERATURE ON INACTIVATION OF CLOSTRIDIUM BOTULINUM TOXIN TYPE E BY GAMMA RAYS. Licciardello, J. J.; Ribich, C. A.; Goldblith, S. A. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Bacteriol.; 32: 476-80(1969).

At an irradiation temperature of 32°F the inactivation curve for Clostridium botulinum type E toxin was characterized by an

initial lag for the first 2 Mrad followed by an apparent linear portion represented by a D_{10} of 2.1 Mrad. The effect of irradiating at temperatures up to 117.5°F was only to shorten or eliminate the initial lag. A synergistic effect of irradiation temperature was indicated at 91.4 and 105.8°F, but at 117.5°F the toxin appeared more radioresistant. (auth)

27544 HISTOCHEMICAL STUDY OF HEALING WOUNDS: ALKALINE AND ACID PHOSPHATASE. Itoiz, M. E.; Mayo, J.; Cabrini, R. L.; Carranza, F. A, Jr. (Univ., Buenos Aires). J. Oral Surg.; 27: 641-4(Aug 1969).

Histochemical changes in acid and alkaline phosphatase were studied in skin wounds on 102 Wistar rats that were wounded in the back and x-irradiated locally with a dose of 6,000 rads after different healing periods (0.72 to 144 hours). Healing periods studied ranged from 24 hours to 75 days. Irradiated wounds showed alterations in enzymatic distribution that were greater when irradiation was performed earlier in the healing period. Healing is retarded by irradiation. Enzymatic alterations found refer specifically to a decrease in alkaline phosphatase and increase in acid phosphatase. However, irradiated tissues maintain their reparative potential and, in later periods (up to 75 days), there is almost complete healing with the normal enzymatic pattern. (auth)

27545 EFFECT OF MICROWAVES AT X-BAND ON GUINEA-PIG SKIN IN TISSUE CULTURE. 3. EFFECT OF PULSED MICROWAVES ON SKIN RESPIRATION AND BIOCHEMISTRY. Carney, S. A.; Lawrence, J. C.; Ricketts, C. R. (Birmingham Accident Hospital, Eng.). Brit. J. Ind. Med.; 27: No. 1, 72-6 (1970).

Small pieces of guinea-pig skin were exposed to known power densities of pulsed microwaves at X-band (9.6 GHz). The pulse duration was 0.25 microsecond and the pulse repetition frequency 4 KHz. The peak power was thus 1,000 times the mean power. Otherwise conditions were closely comparable with those of previous experiments using continuous microwaves. After exposure the skin was maintained on a nutrient medium in vitro. The respiration of the skin and the uptake of ^{35}S-sulphate, ^{32}P-phosphate, and ^{14}C-L-proline into skin constituents were reduced by exposure. The reduction was very similar to that observed after exposure to the same mean power density of continuous microwaves. The effects are believed to be attributable to heating of the skin. (auth)

27546 PHYSICAL VARIABLES CHARACTERIZING SELECTIVE MITOCHONDRIAL HEAT INJURY BY LASER MICROIRRADIATION. Salet, C.; Lutz, M.; Barnes, F. S. (Hopital, Bicetre, France). Photochem. Photobiol.; 11: 193-205(1970). (In French).

Laser micro-irradiation was used to study the uptake of low levels of stain (Janus Green B) by the mitochondria of tissue culture cells and the selective lesions induced by the irradiation. A comparison of the thermal effects produced in the cells and in a stained model system (albumin), permitted the calculation of the degree of concentration of stain in the mitochondria from the staining media (approximately 500 fold). Evaluation of the various parameters of laser irradiation, particularly thermal events, resulted in optimal irradiation times for measurement of local stain concentration, as well as for the selective destruction of the stained mitochondria. For the studies of the latter phenomenon a lower limit for irradiation duration is set by optical saturation and dielectric breakdown. (auth)

27547 THE REDUCTION OF ^{15}N-LABELLED NITRATE TO NITRITE BY FRESH SOILS FOLLOWING TREATMENT WITH GAMMA RADIATION. Cawse, P. A. (Atomic Energy Research Establishment, Wantage, Eng.); Cornfield, A. H. Soil Biol. Biochem.; 1: 267-74(1969).

Increases in nitrite that were previously observed in four soils from different series after treatment with γ radiation, particularly over the dose range 0.5 to 0.8 Mrad, were further investigated by a ^{15}N tracer technique. It was thought that nitrate reduction to nitrite was taking place, and this mechanism was confirmed by reduction of $^{15}NO_3$ to $^{15}NO_2$ in all of the irradiated soils at medium moisture levels. However, three soils had a lower percentage of ^{15}N tracer than expected in the nitrite pool, and it is considered that direct oxidation of unlabelled ammonium to nitrite is the most likely explanation. (auth)

27548 ENDONUCLEASE FROM MICROCOCCUS LUTEUS WHICH HAS ACTIVITY TOWARD ULTRAVIOLET-IRRADIATED DEOXYRIBONUCLEIC ACID: ITS ACTION ON TRANSFORMING DEOXYRIBONUCLEIC ACID. Setlow, R. B.; Setlow, Jane K.; Carrier, W. L. (Oak Ridge National Lab., Tenn.). J. Bacteriol.; 102: 187-92(Apr 1970).

An endonuclease purified from Micrococcus luteus makes single-strand breaks in ultraviolet (UV)-irradiated, native deoxyribonucleic acid (DNA). The purified endonuclease is able to reactivate UV-inactivated transforming DNA of Haemophilus influenzae, especially when the DNA is assayed on a UV-sensitive mutant of H. influenzae. After extensive endonuclease action, there is a loss of transforming DNA when assayed on both UV-sensitive and -resistant cells. The endonuclease does not affect unirradiated DNA. The results indicate that the endonuclease function is involved in the repair of biological damage resulting from UV irradiation and that the UV-sensitive mutant is deficient in this step. We interpret the data as indicating that the various steps in the repair of DNA must be well coordinated if repair is to be effective. (auth)

27549 ENDONUCLEASE FROM MICROCOCCUS LUTEUS WHICH HAS ACTIVITY TOWARD ULTRAVIOLET-IRRADIATED DEOXYRIBONUCLEIC ACID: PURIFICATION AND PROPERTIES. Carrier, W. L.; Setlow, R. B. (Oak Ridge National Lab., Tenn.). J. Bacteriol.; 102: 178-86(Apr 1970).

An endonuclease purified ~3,200-fold from Micrococcus luteus is active on native ultraviolet-irradiated deoxyribonucleic acid (DNA), but is inactive on unirradiated native or denatured DNA and has no activity toward irradiated denatured DNA. The major type of lesion for the nucleolytic activity is the cyclobutane pyrimidine dimer. The enzyme makes a number of single-strand breaks approximately equal to the number of dimers, but dimers are not excised. This endonuclease—a small molecular weight protein—therefore has all the attributes hypothesized for the first enzyme in the sequential steps in repair of DNA in vivo. Another paper shows that the endonuclease is able to reactivate ultraviolet-irradiated transforming DNA. (auth)

27550 STUDIES ON THE BIOLOGICAL ACTION OF BENZO (A) PYRENE. II. EFFECTS OF GAMMA RADIATION ON INDUCTION OF HEPATIC MICROSOMAL HYDROXYLASES BY BENZO(A) PYRENE. Delwaide, P.; Rondia, D.; Heusghem, C. (Univ., Liege). Biochem. Pharmacol., 18: 959-62(Apr 1969).

The administration of benzo-(a)-pyrene (BaP) to growing rats produces within 24 hrs an important increase of microsomal hepatic enzymes that hydroxylate this hydrocarbon. It also causes protein synthesis and other modifications of the endoplastic reticulum; it releases a signal initiating this sequence of metabolic changes. By use of tritium-labeled BaP, one found maximum activity in the liver after 4 to 6 hours, while the enzymatic activity starts after 6 hrs. The enzymatic induction responds to a certain radiation dose according to a fixed time table. Since the enzymatic action follows different schemes, an attempt was made to pinpoint the effect of radiation on the induction of enzymatic processes by BaP. The rats were injected with 20 mg/kg BaP; after 24 hrs the animals were sacrificed and the supernatant of 9000 g homogenized liver obtained in the customary way. The irradiation was carried out with monochromatic γ-rays (660 keV) using a 2000 Ci source of ^{137}Cs. Variation of distance from the source and exposure period allowed to vary the doses from 0 to 2000 rad. The irradiation effect could be also controlled by administration of the radioprotective cystine before, during, or after exposure. Radiation, BaP, and cystine doses are shown in one table; another shows the time table of reaction to 500, 1000, and 2000 rad from 10 min to 6 hrs after the elapse of 24 hrs. Administration of BaP 4 hrs before irradiation produces much greater enzymatic activity than without irradiation. The radiation effect reaches a maximum at 1500 rad and falls off after 2000 rad. Administration of BaP immediately before irradiation eliminates the lag period of enzymatic action as well as the protective effect of cystine; enzymatic activities caused by BaP are greater upon irradiation than without it. Irradiation never inhibits initiation of enzyme action by BaP, though a partial inhibitory effect of radiation cannot be excluded. (F.J.W.)

Immunology

27551 DRUG-INDUCED IMMUNOLOGIC TOLERANCE: SITE OF ACTION OF CYCLOPHOSPHAMIDE. Many, Amira; Schwartz, Robert S. (New England Medical Center Hospitals, Boston. Tufts Univ., Boston). Proc. Soc. Exp. Biol. Med.; 133: 754-7 (Mar 1970).

The cellular mechanism of immunologic tolerance in cyclophosphamide-treated mice was analyzed. Thymocytes from these animals failed to act synergistically with normal bone marrow cells in heavily x irradiated recipients. By contrast the marrow cells of tolerant mice cooperated with normal thymocytes in the x-irradiated recipients. Tolerance in the drug-treated mice was broken by administration of thymocytes, but not by marrow cells. It was concluded that the target cell in drug-induced immunologic tolerance is a thymus-dependent lymphocyte. (auth)

27552 EFFECT OF ^{90}Sr ON CERTAIN INDICES OF NATURAL IMMUNITY. Nevstrueva, M. A.; Shubik, V. M.; Livshits, R. E. (Leningrad Inst. for Scientific Research in Radiation Protection). Gig. Sanit.; No. 6, 113-15(Jun 1969). (In Russian).

Dynamics of natural immunity in rabbits injected with 50 μCi/kg was studied considering the antibacterial activity of the skin and serum, lysozyme titer blood serum, and phagocytic neutrophil activity. It was found that injection of ^{90}Sr at 5 μCi/kg weight did not reduce the indexes of natural immunity as compared with control rabbits. The presence of autoantibodies was found in the blood of exposed animals. (R.V.J.)

27553 PATTERNS OF DEVELOPMENT OF THE PLASMA CELL REACTION AND IMMUNITY TO SMALLPOX IN IRRADIATED ANIMALS. Kamalyan, L. A.; Engoyan, M. N.; Ter-Pogosyan, R. A.; Vartevanyan, Zh. Ts. Vop. Virusol.; No. 5, 574-8(1969). (In Russian).

The dynamics of formation of antibodies to smallpox vaccine and the patterns of development of the plasma cell reaction were studied in rabbits and guinea pigs irradiated (700 and 300 R, respectively) 48 hr before immunization. Irradiation did not prevent the generalized reaction characteristic of corpuscular antigens from occurring in the organs of the reticuloendothelial system. Irradiated animals exhibited the same succession of involvement of the organs in antibody formation as nonirradiated animals. The first to be involved were the regional lymph nodes, then the spleen, and finally the remote lymph nodes. Besides suppressing the formation of blasts and plasmablasts, irradiation inhibited differentiation of plasmablasts into plasma cells. Despite the similarity of the basic developmental pattern of the plasma cell reaction to introduction of the virus, the animals differed markedly with respect to the intensity of the reaction. Inhibition of the reaction and antibody formation was much less pronounced in guinea pigs than in rabbits, suggesting that the degree of radiation injury to the immunocompetent organs is related to the species sensitivity of the animals to the virus. Plasmablasts appear to be the main producers of antibodies in animals with a weak immunologic response (irradiated rabbits, irradiated and nonirradiated guinea pigs). (JPRS)

27554 A TECHNIQUE FOR IMMUNOASSAY OF HUMAN IgG. Bombardieri, Stefano; Christian, Charles L. (Columbia Univ., New York. Presbyterian Hospital, New York). Proc. Soc. Exp. Biol. Med.; 133: 1366-9(Apr 1970).

An immunoassay procedure based on the use of specific antibody coupled to polyaminostyrene is described. Quantitation of human IgG in the range of 0.1 to 1.5 μg was possible and by minor adjustments the sensitivity could be increased several fold. (auth)

27555 REQUIREMENT OF A NONPROLIFERATING CLASS OF CELLS FOR GENERATION OF IMMUNE RESPONSES IN CELL CULTURE. Goldie, J. H.; Osoba, David (Univ. of Toronto, Ontario Cancer Inst., Toronto). Proc. Soc. Exp. Biol. Med.; 133: 1265-9(Apr 1970).

Numbers of unimmunized CBA spleen cells, too small to give a PFC response in culture by themselves, can produce PFC if they are cultured in the presence of a large number of heavily irradiated cells. The survival after irradiation of the PFC response by normal spleen cells has a D_0 of 95 to 105 rads. In contrast, inhibition of the capacity of heavily irradiated spleen cells to facilitate PFC production by normal cells requires doses greater than 2.5 krads. Attempts to demonstrate the provision of a conditioning factor by the heavily irradiated cells were not successful. However, mixtures of normal and heavily irradiated cells in limiting dilution did result in PFC production. These results are in keeping with the hypothesis that cell–cell interaction between the two cell populations is required for generation of PFC responses in culture. Since it is known that in thymus-marrow synergism in intact animals proliferation of both the thymus- and marrow-derived cell populations is required for PFC production, it is suggested that in culture a third, nonproliferating class of cells is also required. This class of cells can be detected in the spleen and lymph nodes but not in the thymus or bone marrow. (auth)

Ecology

Refer also to abstracts 27499 and 27501.

27556 (AECL-3463) SOME OBSERVATIONS ON ALGAE INVADING A ^{137}Cs CONTAMINATED POND. Dugle, Janet R.; Guthrie, J. E. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Jan 1970. 12p. Dep. CFSTI (U. S. Sales Only). AECL $0.50.

A comparison of the species of algae found at various collection sites within two ponds, one contaminated with ^{137}Cs, was made in October, 1968. These observations will form the basis of a study of the succession of algal species in pond communities. (auth)

27557 (ANL-7615, pp 229-31) BEHAVIOR OF FALLOUT ^{137}Cs IN AQUATIC AND TERRESTRIAL ENVIRONMENTS. Gustafson, P. F.; Brar, S. S.; Nelson, D. M.; Muniak, S. E. (Argonne National Lab., Ill.).

Fallout ^{137}Cs in terrestrial systems was found to be highly dependent upon fallout rate, where total deposition seems more important in the aquatic case. In both situations a general downward trend has been evident since 1964 to 1965. (auth)

27558 (BMI-171-30) MATHEMATICAL METHODS FOR EVALUATING THE TRANSPORT AND ACCUMULATION OF RADIONUCLIDES. Bioenvironmental and Radiological-Safety Feasibility Studies, Atlantic–Pacific Interoceanic Canal, Bloom, S. G.; Levin, A. A.; Martin, W. E.; Raines, G. E. (Battelle Memorial Inst., Columbus, Ohio). 3 Apr 1970. Contract AT(26-1)-171. 40p. Dep. CFSTI.

The mathematical methods used for evaluating the transport and accumulation of radionuclides for the radiological feasibility studies are described. Some differential equations for describing the biological transport are derived, and representative methods for obtaining the transfer coefficients are given. Analytical, finite-difference, and semianalytical methods for solving the differential equations are briefly described and a few methods are presented explicitly with examples. The analytical methods include the use of the Laplace transform technique to obtain expressions for the infinite-time radiation dose from internally deposited radionuclides. The mathematical methods are applied toward developing expressions for estimating the internal radiation dose to man which might result from the use of nuclear explosives for excavating craters. The application consists of using a simple but highly conservative mathematical model based on specific activity in order to place an upper bound to the dose from each radionuclide. (J.C.W.)

27559 (CONF-690540–, pp 220-34) COMPARISON OF RADIOACTIVE CONTAMINATION OF THE TOTAL FOOD FOR GROWING YOUTH IN THE COMMUNITY. Smeets, J.; van der Stricht, E. (European Communities, Luxembourg. Commission). (In German).

Within the countries of the European community, a comparative study of fallout effects on food was performed, especially with respect to young people. Although food composition differed considerably between the participating countries, ^{90}Sr activity varied not more than by a factor of 2. In addition, statistics showed that ^{90}Sr uptake by milk and milk products was less than that by cereals. From 1965 through 1967 direct contamination of food showed a significant decrease. (H.B.G.)

27560 (CONF-690540–, pp 289-97) NEW DETERMINATIONS OF THE BIOLOGICAL HALF-LIFE OF ^{14}C IN HUMAN BONES ON INCORPORATION OF CARBON IN ORGANICALLY BOUND FORM. L'Orange, R.; Zimen, K. E. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). (In German).

To determine the mean ^{14}C content of foods for the years 1953 through 1966, bottled wine was used. Like potatoes and sugar beets, grapes assimilate ^{14}C and incorporate it into sugar that is later fermented into alcohol. If the 1953 ^{14}C values are set at 100, nuclear test explosions resulted in an increase with a 196 peak reached in 1963. Based on the wine data, the ^{14}C content of bone was determined in persons that died at an age range from 56 to 88 years. The data gave the biological half-life of ^{14}C in bone as 10 ± 1 yr, and in collagen as 18 ± 2 yr. It was concluded that the maximum body burden, thus far applied, was too high and should be lowered to not more than 40 μCi of ^{14}C. (H.B.G.)

27561 (COO-1156-34) RADIOCESIUM KINETICS IN THE COMPONENTS OF A MONTANE LAKE ECOSYSTEM. Gallegos, Anthony F. (Colorado State Univ., Fort Collins. Dept. of Radiology and Radiation Biology). Dec 1969. 342p. Dep. CFSTI. Thesis.

The effect of temperature and weight of fish on the retention of radiocesium by rainbow trout was studied in a laboratory aquarium system designed to have refrigeration capacity, and to provide for treatment of solid and dissolved organic matter derived from fish wastes. A weight/temperature interaction term was shown to affect the overall excretion pattern of radiocesium as a function of time. Retention half-times of the long component in these fish were observed to be affected not only by a weight/temperature interaction term, but also by the percent weight increase of the fish during the test interval. Laboratory experiments with Gammarus lacustris in aquaria contaminated with ^{134}Cs showed that the concentration factor of these organisms at equilibrium was largely dependent on the water radiocesium concentration. Limnological

studies at East Twin Lake (ETL) provided most of the necessary information required for proper description of this ecosystem in terms of radiocesium movement and pool size estimates. The total ^{137}Cs inventory of ETL was estimated to be 10 mCi. (auth)

27562 (UCRL-50786) RADIOECOLOGICAL STUDIES OF AMCHITKA ISLAND, ALEUTIAN ISLANDS, ALASKA. II. GAMMA-EMITTING RADIONUCLIDES IN THE TERRESTRIAL ENVIRONMENT. Koranda, John J.; Martin, John R.; Wikkerink, Robert W.; Stuart, Marshall (California Univ., Livermore. Lawrence Radiation Lab.). 8 Dec 1969. 44p. Dep. CFSTI.

Plant and soil samples collected on Amchitka Island and in continental Alaska in 1967 and 1968 were analyzed for gamma-emitting radionuclides with conventional NaI crystal detectors and solid-state lithium-drifted germanium diodes. Of the radionuclides found in the plant and soil samples, ^{137}Cs was the most prominent, and ^{155}Eu, ^{125}Sb, ^{144}Ce, and ^{54}Mn were observed in low but detectable levels. The presence of $^{95}Zr/^{95}Nb$ in the 1967 samples suggests that fallout from Chinese atmospheric testing had been recently deposited on Amchitka Island. The environmental half-lives calculated for ^{137}Cs at Amchitka Island and two continental Alaskan areas ranged from 2.1 to 6.8 years. (auth)

27563 ENVIRONMENTAL MOBILITY OF ^{137}Cs. Rogowski, A. S.; Tamura, T. (Oak Ridge National Lab., Tenn.). Radiat. Bot.; 10: 35-45(Feb 1970).

During a 2-year study, erosion soil losses of 53, 2.5 and 0.9 metric tons/ha were coupled with ^{137}Cs losses of 43, 19, and 7 per cent, on 2.3 × 2.3 m bare soil, poor meadow and good meadow plots respectively. Runoff and erosion losses of ^{137}Cs from vegetation-covered plots occurred primarily in the initial stages following the application, due to washoff from vegetation, at a rate approximately ten times greater than would be expected on the basis of soil loss alone. Evidence of ^{137}Cs redistribution was determined by sampling and analysis techniques which facilitate a fair material balance. Uptake of ^{137}Cs by new vegetation was only a small fraction of originally applied ^{137}Cs. An empirical relationship between cesium loss and soil loss of the form: $T = A(x/b)^n$, where T = Cs loss, x = soil loss, b = a units constant, A = a coefficient and n = an exponent, fits the data well. These results indicate that movement of radionuclides by runoff and erosion may be quite important. (auth) (UK)

27564 HAZARDS IMPLICATION OF THE TRANSFER OF UNSUPPORTED ^{210}Po FROM ALKALINE SOIL TO PLANTS. Watters, R. L.; Hansen, W. R. (Colorado State Univ., Ft. Collins). Contract AT(11-1)-1733. Health Phys., 18: 409-13 (Apr 1970).

A study of plants grown in $^{210}PoO_2$ contaminated alkaline Brown soil indicated a small but definite uptake through the root system. The concentration in various tissues varied with species and growing time. A hazards analysis revealed that a surface concentration of 3.1×10^{-3} Ci/m^2 on an agricultural area composed of an alkaline Brown soil could produce a radiological health problem for more than one year because of root uptake in edible vegetables. (auth) (UK)

27565 HAZARDS OF TRITIUM FROM CONTROLLED FUSION. Rose, D. J. (Massachusetts Inst. of Tech., Cambridge). Health Phys.; 18: 439-40(Apr 1970).

Calculations of tritium levels which could be produced in the environment if all the world's power were produced by nuclear fusion are given. The figures are discussed in relation to the permissible dose levels according to the International Commission on Radiological Protection and the conclusion is reached that no hazards would exist. (UK)

27566 SUPERVISION OF THE EXPOSURE TO IONIZING RAYS AT HIGH ALTITUDE AND OF RADIOACTIVE CONTAMINATION OF PLANES ON LONG DISTANCE FLIGHTS. Moroni, J. P.; Pellerin, P.; Ervet, P. Bull. Inst. Nat. Sante Rech. Med.; 23: 1165-98(1968). (In Italian).

The risk of external irradiation and of internal contamination in long distance aircraft may be considered minimal with the present level of fallout. With supersonic travel, danger could arise only in the case of a solar explosion of a force of an order of magnitude similar to the greatest explosions recorded up to the present, an unlikely event. (Excerpta Med.)

27567 CARDIOPULMONARY FUNCTION IN URANIUM MINERS. Trapp, E.; Renzetti, A. D. Jr.; Kobayashi, T.; Mitchell, M. M.; Bigler, A. (Univ. of Utah, Salt Lake City. Veterans Administration Hospital, Salt Lake City). Amer. Rev. Respirat. Dis.; 101: No. 1, 27-43(1970).

Respiratory physiologic studies in 34 uranium miners with known cumulative radiation exposure showed relatively mild airway obstruction, pulmonary overinflation, decrease in pulmonary compliance, reduced oxygen uptake during exercise, hyperventilation, reduced arterial oxygen saturation following exercise, and increase in physiologic dead space. The degree of physiologic abnormality was more severe in those miners with evidence on chest films of nodular silicosis or diffuse pulmonary fibrosis than in those with a normal chest film, but there was no qualitative difference in the results between the two groups. Four subjects, three of whom had normal chest films, had pulmonary artery hypertension during exercise, and in two of these, pulmonary arterial wedge pressure was also abnormal. The findings are interpreted as indicative of a widespread pathologic process, probably fibrotic in nature and located so as to impair function at the bronchiolar, arteriolar, and, in some instances, venular levels. Although the relative roles of free silica and inhaled radioactivity could not be clearly distinguished, it is suggested that the α radiation from daughter products of radon attached to dust in uranium mines probably enhanced the fibrogenic effect of silica in the lung. (auth)

Genetics and Cytogenetics

Refer also to abstracts 27523, 27641, 27658, 27694, and 27717.

27568 (CEA-N-1252) DOMESTIC RABBIT CHROMOSOMES FROM LEUKOCYTE CULTURES AND THE KINETICS OF THEIR RESPONSE TO ^{60}Co GAMMA RADIATION. Gueneau, Gerard (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1970. 21p. (In French). Dep. CFSTI (U. S. Sales Only).

The technique used to obtain rabbit chromosomes from leucocyte cultures is described, and an outline is given of the first results obtained in the study of the kinetics of their response to ^{60}Co γ-rays as a function of the length of time in culture and the exposure dose. Blood was irradiated in vitro with 100 to 600 rad doses, and whole-body doses of 200 to 300 rad were given to rabbits in vivo. Photographs of metaphase chromosomes and chromosome anomalies are presented. A table is presented to show effects of dose and length of culture time on per cent of dicentric and annular chromosome aberrations. (H.L.W.)

27569 (CONF-690540--, pp 273-88) GENETIC TRANSMUTATION EFFECTS FROM INCORPORATION OF RADIOACTIVE MATERIALS. Scheuermann, W. (Technische Universitaet, Hanover (West Germany). Institut fuer Strahlenbiologie). (In German).

Chemical changes caused by the decay of tritium, ^{14}C, and ^{32}P incorporated into biological materials are reviewed with emphasis on effects on DNA. The actual damage is smaller than the theoretically expected value; recovery processes are discussed. (32 references.) (H.B.G.)

27570 MUTATIONS INDUCED IN PEA BY X-IRRADIATION OF POLLEN AND THE SIGNIFICANCE OF INDUCED UNSTABLE CHROMOSOMES IN MUTAGENIC EXPERIMENTS. Monti, L. M.; Saccardo, F. (CNEN, Rome). Caryologia; 22: 81-96(1969). (RT/BIO(69)23).

In the pea variety Parvus, emasculated flowers were pollinated with either x irradiated or unirradiated ripe pollen. Of 277 M_1 plants grown following 750 R irradiation, 9 M_1 plants segregated in M_2 for mutations; all their sectors analyzed (main stems and branches) were involved in the mutations. Cytological analysis of M_2 mutant types (variegated and chlorina-maculata leaf) revealed the presence of unstable chromosomes such as dicentrics (in two mutations) and rings (in three mutations); the mosaic leaf phenotypes were due to breakage-fusion-bridge cycles included in the transmission of such chromosomes. Trisomic (2n = 15) plants, besides normal and mosaic leaf phenotypes, originated in the M_2 segregation of the variegated and chlorina-maculata M_2 mutants. The experiment showed that pollen treatment did not induce sectorial chimera in the M_1 pea plants, so that a high segregation ratio of the induced mutations was obtained; this held true also when persistant chromosomal abnormalities involving breakage-fusion-bridge cycles, such as dicentrics and rings, were induced with a subsequent mixochimeric structure in the M_1 plants. (auth) (C.O.)

27571 FERTILITY OF AUXOTROPHIC MUTANTS OF VARIOUS E. COLI SEROTYPES OBTAINED BY MEANS OF UV-IRRADIATION. Generalov, O. V. Mikrobiol. Zh.; 31: 78-82 (Jan-Feb 1969). (In Ukrainian).

The possibility of obtaining induced mutations in various serotypes of the colon bacillus was studied. Ultraviolet rays were used as an inducer. Auxotrophic mutants were isolated that were dependent on different amino acids. The mutants appeared easier in nonpathogenic strains. Insufficiency always arose in one amino acid. After determining the type of the dependence, recipient strains were distinguished among the obtained mutants by means

of crossing with standard donor HfrH. From 15 cultures involved in conjugation, 6 proved to be fertile, being recipients in crossing with the donor. Female cells were distinguished among both pathogenic and nonpathogenic strains of E. coli. Recombination was realized between the donors and recipients, which testifies to genetic compatibility of various types of the colon bacillus. (auth)

27572 DWARF-TWISTED: AN INDUCED MUTATION IN TRITICUM DURUM DESF. Bozzini, A.; Monti, L. M. (CNEN, Rome). Euphytica; 18: 135-43(1969). (RT/BIO(69)26).

A mutant phenotype, mainly characterized by undulated leaf surface, dwarfism and sterility, was repeatedly induced by physical (x rays, thermal and fast neutrons) and chemical (diethylsulfate and ethylmethanesulfonate) mutagenic agents in different varieties of durum wheat. This phenotype was easily detectable at the seedling stage. Neutron treatments were the most effective method to induce this phenotype and a maximum of 0.6% mutations per M_1 spike-progeny was induced after the highest dose of thermal neutrons. On the average 0.23 mutations per 100 M_1 spike progenies and 0.55 mutant seedlings per 1000 M_2 plants were found after all treatments. Genetic analysis of different dwarf-twisted phenotypes showed that this character is conditioned by one recessive gene with an average segregation ratio of 22.9%. As the dwarf-twisted phenotypes segregated in highly fertile M_1 spikes and no evident chromosome changes were detected in this caryotype, the hypothesis of a point mutation is proposed. (auth)

27573 GENETIC EFFECTS OF A GAMMA FIELD ON THE WD MAIZE LINE. Cerny, J. (Univ. of Agriculture, Prague). Genet. Slechteni; 5: 107-14(Jul 1969). (In Czech).

The genetic effectiveness of the individual zones of the gamma field of the Research Institute of Forestry and Game Management in Zbraslav-Strnady (a bevelled plane disc of 3 hectares with a diameter of 110 m, in the centre of which a ^{60}Co irradiator has been placed) was studied. The activity of the irradiator was 377 gram equivalents of radium. Maize (Zea mays) line WD was used to detect the genetic effects of the γ field. The maize plants were chronically irradiated with doses of 8734 to 88 R during vegetation. The pollen of the irradiated plants was tested for mutation of the Y gene. In the inbred progenies of generations G_2 and G_3 the frequency of chlorophyll mutations was determined. The frequency of mutations of the Y gene in the G_1 generation demonstrated the homogeneity of the genetic effect of the γ field in Strnady in its internal, central, and peripheral parts, corresponding to a dose range of 8734 R to 139 R during vegetation. The maximum frequency of endosperm and chlorophyll mutations was determined in the central zone of the γ field, i.e., at a distance of 51 to 70 m from the irradiator, corresponding to a dose of 335.7 to 176.69 R during vegetation. (auth)

27574 EFFECT OF FRACTIONATION OF THE DOSE IN THE IRRADIATION OF DORMANT PEA SEEDS WITH THE GAMMA RAYS OF ^{60}Co. Tsarapkin, L. S.; Tsarapkina, K. A. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiologiya; 10: 89-93(Jan-Feb 1970). (In Russian).

Dry (6% water) and moist (17 to 18% water) dormant pea seeds were irradiated with γ rays once or in fractions with a total dose of 15 krad at 4200 to 5000 rad/min and compared with the action of the same dose at 42 to 50 rad/min. Lower cytogenetic effectiveness of γ rays in the case of a high dose rate and an increase in the effect of damage with increasing degree of fractionation of the dose to the value observed in the case of irradiation at a dose of 15 krad at 42 to 50 rad/min were established. The phenomenon was observed only on moist seeds. (tr-auth)

27575 INFLUENCE OF COMBINED IRRADIATION ON THE FREQUENCY OF CHROMOSOMAL ABERRATIONS AND THE MITOTIC ACTIVITY IN THE EPITHELIUM OF THE RAT SMALL INTESTINE. Zhorno, L. Ya. (Scientific Research Inst. of Radiation Hygiene, Leningrad). Radiobiologiya; 10: 122-3(Jan-Feb 1970). (In Russian).

The dynamics and peculiarities of the cytological changes in the epithelium of the rat small intestine under various conditions of radiation were investigated. In the case of external x irradiation, changes in the frequency of aberrant mitoses developed and disappeared relatively rapidly; in the case of internal irradiation by incorporated isotopes (^{144}Ce and ^{89}Sr) the development was slower. Under the combined action of these two radiation factors, two phases were noted, reflecting the influence of external and internal irradiations. Changes in the mitotic index were detected primarily after external and combined radiation influences. (tr-auth)

27576 REPAIR OF VISIBLE MUTATIONS AND LETHAL INJURIES IN CHLORELLA. Vekshina, L. K.; Kogan, I. G.; Rogatykh, N. P.; Sakovich, I. S.; Shevchenko, V. A. (Inst. of General Genetics, Moscow). Biol. Nauki; No. 10, 105-7(1969). (In Russian).

Mutations were induced with γ rays in the haploid unicellular alga Chlorella vulgaris at the start of the G_1 stage. Increasing the dose rate from 9.2 to 96 rad/sec increased the number of mutant cells and reduced the survival rate. The survival rate rose after 5 hours of incubation of irradiated cultures in the dark in distilled water, but the number of mutations decreased. A relation was observed between the number of visible mutations, survival rate, and duration of postradiation incubation of starved cells. The increased survival rate with postradiation incubation is thought to be the result either of repair of lethal injuries or of the survival of light-sensitive mutants. (JPRS)

27577 INDUCTION OF FILAMENT FORMATION AND THYMINELESS DEATH IN ESCHERICHIA COLI K-12. Gherardi, M.; Sicard, N. (Faculte des Sciences, Toulouse). J. Bacteriol.; 102: 293-5(Apr 1970).

Mutants of Escherichia coli K 12 were induced by introducing the lon$^-$ marker into the parental strain and by ultraviolet radiation of the parental strain. Mucoidal mutants were tested for filament-forming ability after a low dose of uv light. For thymine deprivation experiments, stationary phase cultures were exposed to uv light under constant shaking. Results showed that there was not necessarily a relationship between filament formation and thymineless death. (H.L.W.)

Health Physics and Safety

Refer also to abstracts 27180, 27238, 27315, and 28933.

Radioactive Contamination and Decontamination

Refer also to abstracts 27234, 27235, 27312, and 27562-27564.

27578 (EIR-176) USE OF PARAFFIN OIL FOR REDUCTION OF CONTAMINATION HAZARDS. Suter, F. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Feb 1970. 12p. (In German). Dep. CFSTI (U. S. Sales Only).

The control of loose, easily airborne contamination is one of the main problems in health physics. Work with components contaminated with loose radioactive material involves risks of contaminating the breathing air and the working place and increases the incorporation risk for the workers. By reducing these two hazards to a single one, a fixed surface contamination, the overall risk can by considerably lowered. At the Swiss Federal Institute for Reactor Research (EIR), Würenlingen, this problem was studied in detail and a practical solution was found in the application of paraffin oil. This new technique was used for simple handling of contaminated tools as well as for the wrecking of Plutonium-contaminated glove boxes in simple, ventilated plastic tents. (auth)

Dosimetry and Monitoring

Refer also to abstracts 27236, 27325, 27337-27339, 27345, 27346, 27396, 27436, 27443-27446, 27448, 27450, 27457, 27504, 27559, 27707, and 28643.

27579 (ANL-7615, pp 76-81) IMPROVED CONSTRUCTION OF RADIOACTIVE PHANTOMS WITH ARBITRARY SOURCE DISTRIBUTION. May, Harold; Marinelli, L. D.; Hess, Paul (Argonne National Lab., Ill.).

The substitution of beads or pellets instead of liquids is proposed for the convenient loading of radioactive phantoms. An analysis of the general problem suggests that mixtures of active and inactive beads are perhaps most immediately convenient, whereas the use of loaded lattices offers simplification and use of a library of simulated and economical organs. (auth)

27580 (ANL-7615, pp 204-6) NEUTRON EXPOSURE TO LUNAR ASTRONAUTS. Kastner, Jacob; Oltman, B. G.; Feige, Yehuda; Gold, Raymond (Argonne National Lab., Ill.).

The flux and energy distribution of neutrons generated by cosmic rays in lunar material was inferred from a knowledge of the situation at the earth's surface. It is suggested that lunar astronauts may suffer significant exposure to thermal neutrons so that their tissue sodium could well be activated to ^{24}Na. It would be very informative for the future assessment of risks to personnel on the moon to subject lunar astronauts to whole-body counting. (auth)

27581 (CONF-690540-, pp 329-55) NEW POINTS OF VIEW AND RECOMMENDATIONS OF THE ICRP FOR INTERNAL RADIATION BURDENS. Hug, O. (Munich Univ. (West Germany). Gesellschaft fuer Strahlenforschung m.b.H., Neuherberg bei Munich (West Germany). Institut fuer Biologie). (In German).

Methods for determining maximum permissible concentrations by the ICRP are discussed especially with respect to bone seeking radioisotopes and those radioisotopes that are deposited within the

respiratory tract. Among the bone seekers, three classes are distinguished. Calcium, radium, and strontium are deposited mainly in the bone substance itself. Plutonium and thorium are deposited predominantly within the endosteum and, to a lesser degree, in the periosteum. Americium and other transuranium elements are deposited on the surface of the bone. The role of the various modes of deposit is discussed with respect to tumor induction. Inhalation of radioactive material is restricted mainly to the discussion of ^{222}Rn. Problems encountered in uranium mining are emphasized. (H.B.G.)

27582 (CONF-690540–, pp 356-79) INCORPORATION DETERMINATION BY SEGREGATION ANALYSIS. METHODS AND RESULTS. Schieferdecker, H. (Kernforschungszentrum, Karlsruhe (West Germany)). (In German).

Routine procedures for monitoring personnel at the nuclear research center at Karlsruhe are discussed, especially for tritium, plutonium, and uranium. Methods for collecting, preparing, and counting the radioisotopes are described. Findings are presented in seven figures and six tables. (H.B.G.)

27583 (CONF-690540–, pp 380-90) RESULTS AND EXPERIENCE IN INCORPORATION MONITORING BY THE RADIATION MEASUREMENT STATION OF THE INDUSTRIAL INSPECTION OF NORDRHEIN-WESTFALEN. Erlenbach, H. (In German).

The radiation detection division of the department for industrial inspection in the state of Nordrhein/Westphalia conducts whole-body counting and liquid scintillation counting of urinary samples and fluorometric urinalysis for uranium. Findings during five years of operation are presented in tables. Significant incorporations occur only during open handling of tritium, ^{131}I, and ^{203}Hg. Moreover, repeated incorporation of significant amounts by the same person is characteristic for tritium; simultaneous incorporation into a group of persons is characteristic for ^{131}I. (H.B.G.)

27584 (CONF-690540–, pp 439-40) DOSE BURDENS OF DOCTORS AND PERSONNEL IN MEDICAL ISOTOPE INSTITUTES. Koetzing, F. (Staedtische Krankenanstalten, Karlsruhe (West Germany). Strahlenklinik). (In German).

During 1968, 71,696 diagnostic isotope procedures were performed at the isotope laboratory of the Karlsruhe city hospital. Two thirds of these involved thyroid tests, one quarter kidney examinations, and the remainder investigation of lungs, liver, and spleen. The personnel consisted of one physician and three medical technicians. Film dosimeters never showed significant doses. Whole-body counting resulted in: physician, 0.68 μCi; first technician, 0.063 μCi, second technician, 0.005 μCi; and third technician, 0.002 μCi. Forty percent of the total activity was concentrated in the thyroid as ^{131}I. It was concluded that in a well organized medical laboratory with extensive experience in the diagnostic use of radioisotopes, significant exposures and incorporations can be avoided. (H.B.G.)

27585 (CONF-690540–, pp 548-75) USE OF A LET SPECTROMETER IN RADIATION PROTECTION DOSIMETRY. Nachtigall, D. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). (In German).

The concepts of energy dose and linear energy transfer, LET, are theoretically analyzed with respect to radiation protection and radiobiology. Twenty-three mathematical equations are derived. A special measuring device and procedures for data evaluation are described. Twelve figures are presented and eighteen references are given. (H.B.G.)

27586 (CONF-690540–, pp 586-95) PROBLEMS OF ESTIMATING THE RADIATION DOSE FOR PROTECTION PURPOSES FROM VERY HIGH ENERGY RADIATION. Baarli, J. (European Organization for Nuclear Research, Geneva (Switzerland)).

Difficulties in the evaluation of radiation risk from very high energy radiation arise primarily from the occurrence of nuclear processes and the presence of a variety of secondary radiation in the tissue. Calculations made under such circumstances have provided flux-to-dose conversion factors for neutrons and protons up to 1 GeV, but the application of these factors to actual situations creates difficulties particularly in interpretation. For this reason simplified integral methods based on the activation of ^{11}C from ^{12}C in plastic phosphors are used. Some of the experimental evidence available at present which makes it possible to interpret such measurements for practical radiation protection purposes is discussed in this paper. (auth)

27587 (CONF-690540–, pp 605-10) NEUTRON DOSE RATE MEASUREMENTS INSIDE THE IRRADIATION CHAMBER OF A 35-MeV BETATRON. Michel, Lothar (Rudolf-Virchow-Krankenhaus, Berlin (West Germany). Abteilung fuer Strahlungsphysik). (In German).

By means of a BF_3 tube, neutron doses were measured in the direct beam of a 35 MeV betatron. With the primary beam centered at the middle of a water phantom, the neutron dose to the eye and gonad regions was 0.1‰ of the electron beam and 1.5‰ of the bremsstrahlung beam. Corresponding scattered doses of γ radiation were 0.8‰ and 1.6‰, respectively. (H.B.G.)

27588 (CONF-690540–, pp 611-13) USE OF CONTINUOUS DOSIMETERS FOR CONVENTIONAL FLUOROSCOPY AND BV FLUOROSCOPY. Magnus, H. E. (Staedtische Krankenanstalten, Karlsruhe (West Germany). Strahlenklinik). (In German).

To evaluate the radiation burden to both patient and physician, dose measurements were performed during routine fluoroscopic examinations of the gastrointestinal tract. As a general rule, the total dose declined after the first or second examination and increased again after the sixth or eighth examination. As compared to the minimum doses, initial and end doses were higher by a factor of 2 to 3. (H.B.G.)

27589 MEASUREMENT OF SCATTERED RADIATION TO BODY AREAS DURING RADIOTHERAPY OF BASAL-CELL EPITHELIOMAS. Petratos, Marinos A.; Grisewood, Edgar N.; Wingate, Catharine (New York Univ., N. Y.). Dermatol. Int.; 8: 10-13(Jan-Mar 1969).

Scattered radiation to various body areas was measured by the use of thermoluminescent dosimeters when basal-cell epitheliomas of the face were treated with 3,400 R of x rays. The results suggest that the described method of irradiation resulted in minimal scatter. (auth)

27590 DOSIMETRY OF ELECTROMAGNETIC FIELDS FROM LOW TO ULTRAHIGH FREQUENCIES. pp 62-3 of Elektromagnitnye Polya i Zhivaya Priroda. /Presman, A. S. Moscow; Izdatel'stvo Nauka (1968). (In Russian).

The intensity of electromagnetic fields of low and high frequencies (up to tens of MHz) in industry or in animal experiments has to be evaluated mostly in the induction field, where the intensities of electrical and magnetic field components (E and H) must be measured separately. This involves several technical difficulties: the measuring device has to cover a variety of ranges for E and H, and the direct effect of the fields on the device (besides the antenna) and the distortion produced by the device in the field have to be avoided. In the Soviet Union several devices have been constructed that solve these problems in a more or less satisfactory way, and are suitable for frequencies from 50 Hz to tens of MHz, H values from 0.5 to 500 A/m, and E values from 5 to 1500 V/m. In experimental investigations of the effect of an alternating electric field, the biologic object is placed between the plates of the capacitor to which alternating voltage of a given frequency is applied. The magnetic component has to be considered also, unless the sizes of the object and capacitor are small as compared with the wavelength. During the investigation of the effect of an alternating magnetic field, the biological object is placed inside a solenoid supplied with a-c of a given frequency. The electric component can be disregarded in the same case, as indicated for the magnetic component. (JPRS)

27591 DOSIMETRY OF SUPER-HIGH FREQUENCY ELECTROMAGNETIC FIELDS. pp 63-9 of Elektromagnitnye Polya i Zhivaya Priroda. /Presman, A. S. Moscow; Izdatel'stvo Nauka (1968). (In Russian).

Techniques different from those for lower-range waves are required to measure the intensity of super-high frequency waves as well as to apply electromagnetic fields of this range. The following technical peculiarities are important for the biomedical investigations described. Super-high frequency electromagnetic waves are generated in closed metallic chambers, the cavity resonators. Electromagnetic energy can be conducted through coaxial cables or waveguides with a characteristic impedance depending on their geometrical parameters. The electromagnetic waves can be directed with the help of reflectors or horns. If the object serves as a load of the transmission line and its impedance equals the characteristic impedance of the line, it can absorb all the transmitted energy. This condition can be achieved by the impedance transformer. The intensity of the effect of super-high frequency fields on persons exposed during experiments, during work with the generators, or during experiments with irradiation from a distance is usually measured in mW/cm^2, and can be also expressed in erg/cm^2. Devices for measuring the intensity of super-high frequency fields are based on transformation of the energy of these fields into d-c, whose magnitude indicates the intensity value. Several Soviet and foreign (1949 to 1965) measuring devices, radiators, and methods of placing the biological object are described. (JPRS)

27592 MEASUREMENTS OF THE QUALITY FACTORS OF FAST NEUTRONS. De Franceschi, L. G. Fis. Sanit. Prot. Radiaz.; 12: 149-54(1968). (In Italian).

In the dosimetry of fast neutrons for the purpose of radioprotection it is indispensable to associate the relative quality factor

with the dose absorbed. The experimental determination of this factor is therefore of special importance. A description is given of a method in which the integral spectra obtained with the proportional counter of Hurst are used for extracting the LET spectra of the recoils H and C and thereby calculating the mean quality factor. In this way a single series of measurements with the counter makes it possible to determine the two qualities, the dose of first collision and the quality factor relative to it, from which it is not difficult to arrive at the equivalent dose. The use of the method is particularly convenient and some of the results obtained are reported and commented upon. (Excerpta Med.)

Radiation Protection

Refer also to abstracts 27708, 27905, and 28388.

27593 (CONF-690540) RADIATION PROTECTION PROBLEMS IN THE RELEASE AND INCORPORATION OF RADIOACTIVE MATERIALS. 4th ANNUAL MEETING OF THE ASSOCIATION OF SPECIALISTS FOR RADIATION PROTECTION, BERLIN, 28–30 MAY 1969. Hacke, J.; Jacobi, W. (eds.) (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). 638p. (In German and English).

Separate abstracts were prepared for 55 papers presented at the conference. An additional four papers were presented. (H.L.W.)

For abstracts of individual papers see: 27234–27238, 27312–27315, 27334–27343, 27421–27431, 27506–27508, 27522, 27559, 27560, 27569, 27581–27588, 27594, 27600, 28642, 28643, 28934–28936, and 29045–29047.

27594 (CONF-690540–, pp 397-406) SIMPLE BODY COUNTER ARRANGEMENT FOR INCORPORATION MEASUREMENTS: A GUIDELINE FOR ITS USE IN PRACTICAL RADIATION PROTECTION. Maushart, R. (Laboratorium Prof. Dr. Berthold, Wildbad im Schwarzwald (West Germany)). (In German).

From a practical and economical standpoint it is proposed to screen all persons handling open radioisotopes with a simplified whole-body counter. Individuals who show definite incorporation are then transferred to medical centers with existing stationary whole-body counters for final analysis, and, if necessary, medical treatment. (H.B.G.)

27595 METHODS AND MEANS OF PROTECTION AGAINST ELECTROMAGNETIC FIELDS. pp 74–6 of Elektromagnitnye Polya i Zhivaya Priroda. /Presman, A. S. Moscow; Izdatel'stvo Nauka (1968). (In Russian).

Methods of protection during work in the vicinity of electromagnetic radiation sources or during the conduction of experiments can be divided into passive and active. The passive methods include limitation of the time persons spend in the dangerous area, location of working places at sufficient distances from the source, automation of the work with the sources, or development of remote control. The active measures involve the use of technical means that help to reduce the intensity of electromagnetic field effects to the maximum permissible doses established at the Institute of Industrial Hygiene and Occupational Diseases of the Soviet Academy of Medical Sciences. These means consist of individual protection, such as protective eye glasses and clothing, and shielding of the source of electromagnetic radiation. Special absorbers of electromagnetic energy located in the vicinity of the sources, and sheet metal or wire mesh shielding are used for this purpose. For directed radiation, open shielding lined with absorbing material is used. (JPRS)

27596 RADIATION AND RADIATION PROTECTION. Bevan, John S. (Borough Polytechnic, London). pp 94–142 of Space Environment. /Langton, N. H. (ed.). New York; American Elsevier Publishing Company, Inc. (1969).

This chapter is concerned with the radiation environment in space and its possible effects on man. The radiation components are described: galactic and solar cosmic rays, geomagnetically trapped radiation, cosmic radiation, and x rays. Methods for measuring the radiation on Earth and in space are discussed. Biological effects of radiation doses are discussed, and some of the methods for protection are described. (D.L.C.)

27597 PHOTOCOAGULATION OF THE RETINA BY LASER RAYS. Sci. Progr.-Nature, No. 3411, 250-2(July 1969). (In French).

An instrument for preventing detachment of the retina by laser radiation is described. A cauterization produced by successive impacts of short duration from the ruby laser results in a soldering of the retina and choroid membranes. In experiments on rabbits various doses of laser light were projected on fixed points of the retina. The animals were killed and histological examination of the eyes revealed that intense heat caused a blister on the choroid; cicatrization occurred within a few days. Results of the medical use of the instrument in conjunction with surgery for replacement of the retina appear to be favorable. (H.L.W.)

Safety Procedures

Refer also to abstracts 27034, 27671, and 27703.

27598 (BRH/DEP–70-2) REPORT OF TESTS MADE ON THE WESTINGHOUSE PANORAMIX X-RAY MACHINE. Woodcock, Ray C.; Properzio, William S. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Mar 1970. 35p. CFSTI.

Physical measurements on the Panoramix X-ray machine are described as a partial basis for a radiological health evaluation of this unit. The results of measurements to determine the accuracy of kilovoltage, timer, and current calibrations, and an analysis of the radiation output, distribution, and intensity are presented. Comments are made regarding electrical hazards and the applicability of certain of the NCRP recommendations for medical and dental X-ray machines. (auth)

27599 (BRH/DEP–70-4) EVALUATION OF A NORELCO–PITCHFORD PORTASPEC PORTABLE X-RAY SPECTROGRAPH. Woodcock, Ray C. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Mar 1970. 20p. CFSTI.

A radiation safety evaluation of the Norelco-Pitchford Portaspec, which is the first x-ray spectrograph designed for field use which employs an x-ray tube as the radiation source, is described. An analysis of the primary x-ray beam and of scattered radiation under various conditions of use is presented. Also, comments and radiation safety recommendations are made. (W.H.K.)

27600 (CONF-690540–, pp 391-6) DIFFERENTIAL MEASUREMENTS AFTER INHALATION OF NATURAL URANIUM. Jacobs, H. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). (In German).

At the nuclear research center Juelich, two persons inhaled natural uranium as hexafluoride. Monitoring consisted predominantly of urinalysis with fluorometric determination. Uranium content of urine decreased within the first two weeks to 1% of initial values. Total incorporated amount of uranium was estimated as 500 mg for each case or ¼ of permissible concentrations for single incorporations. (H.B.G.)

27601 (CONF–691001–, pp 3-12) INHALATION CARCINOGENESIS MAN: ENVIRONMENTAL AND OCCUPATIONAL HAZARDS. Nelson, Norton (New York Univ., N. Y. Inst. of Environmental Medicine).

There has now accumulated extensive evidence on the induction of lung cancer via inhalation (including cigarette smoking) in man. The best documented and most decisive evidence relates to occupational exposures. Examples would include radon daughters, chromate chemical manufacturing, and asbestos exposure. There is also evidence suggesting that the generally lower levels of exposures found in community air may be associated with an increased risk of lung cancer. Selected examples of such associations are examined and discussed, and the relation of laboratory studies to such problems is considered. (auth)

27602 (N–70-15709) STUDY OF EARLY NAUSEA AND VOMITING RESPONSE OF SWINE TO IONIZING RADIATION. Final Technical Progress Report, September 15–December 12, 1969. Sullivan, Maurice F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec 1969. Contract NAS9-9188. 36p. (NASA-CR-102076). CFSTI.

Humans experience a prodromal response following exposure to ionizing radiation, either as a result of radiation-therapy treatments or as a consequence of accidental exposure. It is possible that the magnitude of the doses which in some cases cause this response would be encountered during space missions, whether of an intra- or an extra-vehicular nature. Although such a response is uncomfortable and distressing in our normal environment, it could conceivably result in death in a hostile environment. While being merely temporarily incapacitating on earth, in a high performance and reliability situation such incapacitation, however temporary, might lead to an aborted, an incompleted, or even a fatal mission. Furthermore, the consequences of the vomit reflex in a weightless environment are not yet known. It may be that the consequences of such vomiting would be longer than of a temporary nature, such that the performance of the individual might be seriously reduced or terminated altogether. (auth)

27603 BODILY OXYGENATION IN PERSONS WORKING WITH SOURCES OF IONIZING RADIATION FOR LONG PERIODS. Lysina, G. G. (Kiev Inst. of Industrial Health Protection and Occupational Diseases). Vrach. Delo; 8: 100-3(Jun 1968). (In Russian).

A polarographic study of 115 individuals who worked for a long time with sources of ionizing radiation revealed polarographic curves, caused mainly by the presence of neurovascular dystonia and changes of the oxidation-reduction processes in the body. It was concluded that polarography is a valuable method for the investigation of oxygenation changes under the effect of different chemical and physical factors. (auth)

27604 RADIATION BACKGROUND IN THE MINES AND PITS OF GEORGIA. Gabuniya, G. Sh. Gig. Sanit.; No. 11, 48-52(Nov 1969). (In Russian).

The radiation background of the underground air was studied in the pits and mines of Georgia, Soviet Union. In coal mines and pits the γ radiation level was within 10 to 75 mCi/hr. The radon concentration in underground air of the main coal mines fluctuated from 0.8×10^{-14} to 2.2×10^{-11} Ci/l. Certain mines presented a high radiation background. Of 104 determinations made, in 94 cases the concentration of radon was above the level of 3×10^{-11} Ci/l. The causes of mortality of miners and that of all the male population above 18 years old in the mine district for the period from 1959 to 1963 and the picture of white blood cells in underground workers with a service record were studied. No statistically significant changes were determined. Consequently it was concluded that the maximum permissible concentration of radon was not exceeded.

27605 ERYTHROCYTES OF URANIUM MINERS: THE RED BLOOD PICTURE. Vich, Z.; Kriklava, J. (Health Inst. of Uranium Industry, Pribram, Czech.). Brit. J. Ind. Med.; 27: No. 1, 83-5(1970).

Hemoglobin concentrations, erythrocyte counts, hematocrit values, and mean corpuscular volumes, hemoglobin, and hemoglobin concentrations were determined on a group of miners in a uranium mine and in unexposed persons. There were small, statistically significant differences of mean values from those of controls, but the mean values remained well within normal limits. There was no evident damage to red blood cell formation. (auth)

Legal Aspects

Refer also to abstracts 27560 and 27565.

27606 (BNL-14581) THE BROOKHAVEN REPORT. Kouts, Herbert (Brookhaven National Lab., Upton, N. Y.). [nd]. 9p. Dep. CFSTI.

In 1955, the Joint Committee on Atomic Energy of the Congress instituted a study of the need for third party liability insurance, in connection with the operation of nuclear power plants. Because only relatively casual estimates had been made up to then of the theoretical consequences of accidents that could be imagined for such facilities, the Joint Committee turned to the Atomic Energy Commission for advice on this question. In May, 1956, Commissioner Willard Libby presented to the Committee some estimates of damage from conceptual accidents. The Committee also requested that a more extensive study be conducted on an urgent basis, and this information would be furnished as additional background for the framing of possible indemnity legislation. There have been no catastrophic accidents to nuclear power plants, so no data were available. The review of the probability of large accidents was therefore pursued in two other ways. First, a review was made of the features of reactor design and operation that affect the possibility of accidents, to see what might be learned from these. Second, estimates of the probability and resulting damage requiring compensation were solicited from many of the scientists and engineers prominent in the nuclear field. The planning and preparation for safe and efficient introduction of nuclear power that included this study as one component has been an outstanding instance of responsible technological statesmanship. (C.H.)

Medicine

Refer also to abstracts 27325 and 27470.

Protective Substances

Refer also to abstracts 27542, 27643–27653, 27665, 27667, 27701, and 27702.

27607 (ANL-7615, pp 25-32) RECOVERY AND MODIFICATION OF RADIATION-INDUCED DIVISION DELAY IN DEVELOPING SEA URCHIN EGGS. Failla, Patricia (Argonne National Lab., Ill.).

Treatment of fertilized sea urchin eggs with a number of agents that prolong the normal cell division cycle permits recovery during the prolongation period from division delay caused by previous irradiation of one or both gametes. Treatment with several of these agents also modified the subsequent response of fertilized eggs to radiation. Some implifications of the results in the elucidation of the recovery process are discussed. (auth)

27608 RADIOPROTECTION AND RECOVERY BY DITHIOTHREITOL. Falconi, C.; Scotto, P.; De Franciscis, P. (Univ., Naples, Italy). Experientia; 26: 172-3(15 Feb 1970).

The substance dithiothreitol (DTT), though lacking the $-NH_2$ group characteristic of radioprotective molecules, is of interest because of its high erythrostimulating activity, its very low redox potential (–0.33 V at pH 7), and the presence of 2 free –SH groups Male albino Swiss mice were whole-body x-irradiated at 26 R/min for a dose of 625 R. Only 5.6 ± 3.5% survived (of 200 animals). Administration of DTT in the reduced form at doses of 120 mg/kg body weight caused a moderate survival (29 ± 3.4%); at a dose of 80 mg/kg, survival was 15 ± 1.2%; no protection was detected when lower doses were given. The effectiveness of DTT remained the same when given up to 24 hr after irradiation; an effect that seems to be unique among sulfhydryl compounds. The oxidized form of DTT gives survival of 56 ± 0.6% at a dose of 200 mg/kg, and 10% at 120 mg/kg. The oxidized form showed an appreciable radioprotection and recovery effect up to 72 hr after exposure. The oxidized form, used at a concentration twice as high as that of the reduced one, had greater effects (60%) on survival than reduced DTT (30%) in both protection and recovery experiments. Possible explanations for these effects are suggested. (C.O.)

27609 CHEMICAL RADIATION PROTECTION OF RABBIT EYES FOLLOWING EXPOSURE TO ^{60}Co γ. Ruether, W.; Jacobi, K. W.; Kovacs, G.; Graul, E. H.; Neubauer, H. (Univ., Marburg, Ger. Univ., Cologne). Klin. Monatsbl. Augenheilk.; 154: 232-8 (Feb 1969). (In German).

Combinations of chemical substances for protection of rabbit eyes against γ radiation were studied. Serotonin (5-HT) and adenosine monophosphate, DRF = 2.6, and cysteamine (MEA) serotonin, and β-aminoethylisothiuronium = 2.5, were investigated for their protective effect at the anterior eye-segment, particularly the lens, in 30 rabbits. The ^{60}Co γ dose amounted to 1500 rad. A protective effect from irradiation at the anterior eye-segment, particularly at the lens, was achieved with the combinations 5-HT and AMP and MEA, 5-HT, and AET. The protective effect applies to the chronological development of the opacities, the ripening to a mature cataract, to blepharitis and to alopecia. As far as the protective effect from irradiation is concerned, the combination MEA, 5-HT and AET was superior to the combination of 5-HT and AMP. (auth)

27610 EFFECT OF CHEMICAL RADIATION-PROTECTIVE AGENTS ON RABBIT EYES FOLLOWING THE EXPOSURE TO FAST NEUTRONS (15 MeV NEUTRONS). Neubauer, H.; Graul, E. H.; Jacobi, K. W.; Ruether, W.; Kovacs, G. (Philipps-Univ., Marburg, Ger. Univ., Cologne). Klin. Monatsbl. Augenheilk.; 154: 453-8(Mar 1969). (In German).

The effectiveness of various combinations of chemical substances for protection against radiation injury was investigated in 30 rabbits. Combinations of serotonin and adenosine monophosphate, and of cysteamine, serotonin, and β-aminoethylisothiuronium were investigated for their protective effect at the anterior eye-segment, particularly the lens. In comparison to the control animals, opacities occurred in the experimental animals at a later time and were less intensive. Also the effect was more pronounced with regard to the development of cataracts than in appearance of the first incipient lenticular opacities. The combination of cysteamine, serotonin, and β-aminoethylisothiuronium retarded the opacifications for a longer period than the combination of serotonin with adenosine monophosphate. (auth)

27611 NATURE AND KINETICS OF THE FORMATION OF WATER-SOLUBLE PLANT RADIOTOXINS. Merkulov, A. S.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino, USSR). Radiobiologiya; 10: 37-42(Jan-Feb 1970). (In Russian).

The presence of two groups of substances inhibiting the growth and development of young seedlings (radiotoxins) was demonstrated by chromatographic separation. The first group represents substances giving a polarographic wave at $E_{\frac{1}{2}} = -0.35$ V, also present in the normal state, but increasing sharply in irradiated plants. The second group represents substances absent in the normal state, that appear only in irradiated plants but do not possess polarographic activity. The kinetics of formation, molecular weights, and physicochemical and biochemical characteristics of the polarographically active radiotoxins were determined. (tr-auth)

27612 INFLUENCE OF THE GAMMA-IRRADIATION DOSE RATE ON THE RADIOPROTECTIVE EFFECTIVENESS OF BETA-MERCAPTOETHYLAMINE HYDROTARTRATE. Tik-

homirova, M. V.; Yakovlev, V. G. (Inst. of Biophysics, Moscow). Radiobiologiya; 10: 132-5(Jan-Feb 1970). (In Russian).

The radioprotective action of β-mercaptoethylamine hydrotartrate (MEAHT) under conditions of γ irradiation at various rates was investigated. In the case of brief irradiation with a high dose rate, MEAHT effectively protected mice and rats. In the case of prolonged irradiation at a low dose rate, no radioprotective effect of MEAHT was detected. (tr-auth)

27613 SENSITIVITY OF THE TISSUES OF THE GONADS TO IONIZING RADIATION UNDER CONDITIONS OF DEEP COOLING. Novikov, B. H.; Stetsenko, M. A. (Kiev State Univ.). Radiobiologiya; 10: 119-21(Jan-Feb 1970). (In Russian).

The results of experiments on the effects of ionizing radiation on isolated sparrow testes in 8 M ethylene glycol and in liquid air are cited. After irradiation the gonads were transplanted into castrated males. It was established that as a result of preliminary treatment with 8 M ethylene glycol and especially in the case of irradiation in liquid air, the sensitivity of the gonads to ionizing radiation was significantly reduced. (tr-auth)

27614 QUANTITATIVE CHARACTERISTICS OF THE RADIOPROTECTIVE EFFECT OF MEXAMINE. Yarmonenko, S. P.; Suvorov, N. N.; Karochkin, B. B.; Airapetyan, G. M.; Ovakimov, V. G.; Lyarskii, P. P.; Ivanov, V. I. (Inst. of Labor Hygiene and Occupational Diseases, Moscow. Inst. of Experimental and Clinical Oncology, Moscow). Radiobiologiya; 10: 78-82(Jan-Feb 1970). (In Russian).

Experiments on mice and rats established that the duration and degree of the radioprotective effects of mexamine depend upon the amount of the preparation; moreover, the range of its effective doses in the case of various means of introduction is broader than was assumed in earlier investigations. The most correct analysis of this dependence can be performed using a powerful source of radiation, permitting the detection even of a transitory manifestation of effectiveness of the preparation in the range of irradiation doses inducing not only the bone marrow, but also the intestinal syndrome. (tr-auth)

27615 CHEMICAL PROPHYLAXIS OF THE DIRECT AND LONG-TERM EFFECTS OF IRRADIATION BY HIGH-ENERGY PROTONS WITHIN A BROAD DOSE RANGE. Yarmonenko, S. P.; Suslinkov, V. I.; Makarenko, I. G. (Inst. of Experimental and Clinical Oncology, Moscow). Radiobiologiya; 10: 83-8(Jan-Feb 1970). (In Russian).

Experimental evidence of the fact that mexamine protects mice from the direct and long-term effects of whole-body irradiation by 600 MeV protons is cited. The coefficient of protection from death for 30 days after irradiation in the dose range 1300 to 700 rad was 0.6 to 1.0. The weakening of the long-term effects by mexamine was less pronounced. The coefficient of protection from death at doses of 900 rad to 0 in the time interval between 30 and 490 days (by the time of death in the biological control) after irradiation was 0.79 to 0. The value of the protection from shortening of the average lifetime at doses from 900 rad to 0 was 0.61 to 0. The protective effect was also detected according to other indexes of the long-term effects of irradiation (reduced weight of the animals and degree of shedding of hair). (tr-auth)

27616 EXPERIENCES IN THE CLINICAL USE OF INTRAVENOUS INJECTION OF COBALT GREENPOLE AND GREENPOLE MIXTURE AND METALOC AGAINST RADIATION INJURY. Ashizawa, Teruo; Nishiki, Masahiro (Iwate Medical Coll., Morioka, Japan). Shinyaku To Rinsho; 18: 1271-4(Sep 1969). (In Japanese).

On the radiotherapy for malignant tumors, it is required to prevent side effects inducing trouble on peripheral blood cells, liver function, serum protein and radiotoxemia. Observation on the side effect was performed, when the mixture of Cobalt greenpole (cobalt chlorophyllin sodium) and Greenpole (iron chlorophyllin sodium) was injected intravenously (group I) or Metaloc (the mixture of iron-, copper-, and cobalt-chlorophyllin) was given through mouth (Group II) during the radio therapy. About Group I, the decrease of leucocyte by 25 percent, the decrease of erythrocyte by 20 percent and the decrease of serum protein (total protein, albumin, A/G, globulin) occurred, and radiotoxemia appeared apparently in case of radiation to upper abdominal region, but no impediment of liver function appeared. As for Group II, the same result of observation as Group I was obtained. The decrease of leucocyte was 22 percent and the decrease of erythrocyte was 16 percent. It is hard to conclude the effect of medicine because of the various origins of side effect, but it may be tentatively concluded that it is worth while to use these medicines in order to prevent the decrease of leucocyte and erythrocyte. (auth)

27617 SOME THEORETICAL PECULIARITIES OF THE ACTION OF RADIOMIMETICS ON THE CONDENSATION AND PROPERTIES OF SUPERMOLECULAR DNP SYSTEMS. Martynov, E. V.; Spitkovskii, D. M.; Tseitlin, P. I. (Inst. of Experimental Biology, Moscow). Radiobiologiya; 10: 3-8(Jan-Feb 1970). (In Russian).

The effects of radiomimetics (8-ethoxycaffeine and phosphazine) on the formation and rheological properties of supermolecular deoxyribonucleoprotein (DNP) structures were studied. It was shown that phosphazine simulates the effect of ionizing radiation, weakening the intermolecular interaction in the supermolecular structure, whereas 8-ethoxycaffeine leads to the appearance of strong cross-links, reinforcing the structure. Thus, both chemical compounds act intensively at the sites of appearance of weak intermolecular bonds, without breaking down the structure of individual DNA and DNP molecules in solution. (tr-auth)

27618 INCREASED RADIATION EFFECTS ON THE SMALL INTESTINAL EPITHELIUM OF DOGS BY THE USE OF ACTINOMYCIN D. Concannon, Joseph P.; Summers, Roy E.; King, John; Tcherkow, George; Cole, Christine; Rogow, Edward (Allegheny General Hospital, Pittsburgh). Front. Radiat. Ther. Oncol.; 4: 46-52(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

The combination of actinomycin D and x-irradiation of the upper portion of the abdomen of dogs, in doses which, by themselves, produce no significant clinical, histological or biochemical abnormalities, resulted in the death of nine of twelve animals scheduled to receive between 1900 and 3100 R. Marked hypochloremia was observed in more than half of the animals in the groups which received actinomycin D and irradiation. Hyponatremia was observed in only a few animals in the combined treatment groups. The elevation in serum phosphorus observed in many of the animals in the various treatment groups appeared to be related to the administration of actinomycin rather than due to the effects of combined treatment. Bone marrow depression and the depression of lymphocytes observed in this investigation also appeared to be related primarily to the use of the drug. Mechanisms of action for the enhanced response of the intestinal epithelium to irradiation and actinomycin D treatment are postulated. (auth)

27619 COMBINED EFFECTS OF X-IRRADIATION AND CHEMOTHERAPEUTIC DRUGS (NITROGEN MUSTARD AND ACTINOMYCIN D). Elkind, M. M.; Sakamoto, K. (National Cancer Inst., Bethesda, Md.). Front. Radiat. Ther. Oncol.; 4: 53-75(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

Chinese hamster cells were cultured and synchronized by the hydroxyurea method. They were then treated with x-rays, nitrogen mustard, and actinomycin D, either singly or in combination. X-rays and nitrogen mustard behaved in a similar manner by killing cells in the G-1 and G-2 phases more effectively than those in the S-phase. With respect to actinomycin D, however, cells were resistant in the G-2 phase and sensitive in the S-phase. Therefore, complementation of x-rays and actinomycin D appeared feasible for tumor therapy. If, after radiation treatment, the surviving S cells were exposed immediately to actinomycin D, the combined procedure might be highly effective. (H.B.G.)

27620 EFFECT OF RADIATION SENSITIZING AGENTS IN RADIATION THERAPY OF A MOUSE MAMMARY CARCINOMA. Suit, H.; Urano, M.; Hewitt, R. (Univ. of Texas, Houston). Front. Radiat. Ther. Oncol.; 4: 101-5(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

Mammary carcinoma cells of the type C_3H were injected into mice. Local x radiation was given when the tumor reached 8 mm in diameter. Prior to radiation exposure the mice received six injections of IUdR. Highest sensitivity to radiation was achieved with dosage of 0.15 mg/body weight. (H.B.G.)

27621 CLINICAL STUDY OF CHEMICAL RADIOSENSITIZATION. Bagshaw, M. A.; Doggett, R. L. S. (Stanford Univ., Calif.). Front. Radiat. Ther. Oncol.; 4: 164-73(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

An increase in local control of advanced neoplasms of the head and neck was not achieved by combined therapy utilizing intra-arterial methotrexate, 6-mercaptopurine, or 5-bromodeoxyuridine in combination with x-irradiation although marked sensitization tissues within the treatment volume was demonstrated. (auth)

27622 THE USE OF COMBINED ACTINOMYCIN D AND RADIOTHERAPY IN CHILDREN WITH WILMS' TUMOR. D'Angio,

G. J. (Memorial Hospital, New York). Front. Radiat. Ther. Oncol.; 4: 174-80(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

Actinomycin D enhanced radiation effects in single cell systems as well as in normal and neoplastics tissues in animals and in man. The use of both modalities combined with surgery coincided with a significant improvement in the survival rate of children with Wilms' tumor. Some of the problems inherent in the use of combined therapy and of the agent itself were discussed. (auth)

Radiation Sickness and Injuries

27623 RADIATION INJURIES, DIAGNOSIS, AND TREATMENT. Maisin, J. R. (CEN, Mol, Belgium). pp 65-84 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

A summary is presented of present knowledge on short- and long-term effects of radiation in mammals and the diagnosis and treatment of radiation lesions. Acute and late effects and biological indicators are discussed. (65 references). (D.L.C.)

27624 INTERMEDIATE FLAPPING IN RADIATION DAMAGED SKIN. Sommer, P. Klin. Monatsbl. Augenheilk.; 155: 408-13 (Sep 1969). (In German).

On therapeutic employment of ionizing irradiation, cutaneous lesions are brought about that are looked upon as chronic dermatitis due to irradiation. Plastic surgery in skin lesions caused by irradiation is indicated if malignant degeneration takes place in skin irradiated for other reasons, in relapses of an irradiated malignant tumor or in unsuccessful irradiation, and for coverage of a defect in ulcerations from irradiation. Because of the insufficient stretching and shifting capability of the radiation-injured skin, a free transplantation is recommended. The intermediate flap seems to be especially suitable, as it heals well on account of its compatibility with regard to the underlying tissue and the poorly capillarized injured skin and as it does not contribute to further induration through shrinking in the sclerosed environment. (auth) (C.O.)

27625 USE OF SOLCOSERYL IN DERMATOLOGICAL THERAPY. Kozminska, Anna; Rozanski, Jedrzej; Rogalska, Maria. Przegl. Dermatol.; 56: 651-8(Sep-Oct 1969). (In Polish).

Solcoseryl was applied in 79 patients from 11 to 78 years old. Among them were 37 patients with varicose leg ulcers, nine with ulcerations in the course of scleroderma, three with neurotrophic ulcerations, three with burns, 18 with immediate and delayed x-radioinduced reactions, and nine with other skin lesions. In most cases a good therapeutic result was achieved with the concurrent administration of solcoseryl in the form of injections, gel, and ointment. In cases of immediate x-radioinduced reactions local treatment was sufficient. (auth)

Radiodiagnosis

Refer also to abstracts 27327–27329, 27340, 27396, and 27711.

27626 (UCLA-34-P-119-23) CLINICAL APPLICATIONS OF A HIGH QUANTUM UTILIZATION SCANNER. Annual Progress Report, 1968-69. (California Univ., Los Angeles). Contract AT(11-1)-34. 19p. Dep. CFSTI.

Progress is reported on the three principal areas of investigation: clinical trials of scanning procedures for the interpretation of brain scans, measurements of the content of calcium in biopsy samples of human brain tumors, and radiochemical syntheses of some chelated tracer compounds. A number of data-recording systems that aid in the comparison of conventional and section scanning procedures for accuracy and reliability in identifying brain lesions are described. Modifications that have improved the performance of the second model of the section scanner are described. The study of calcium content is of interest in relation to the surface properties of brain tumor cells. A wet-ashing method was developed for calcium determination that gives consistent results. Initial results suggested some significant differences in calcium content for certain tumor types. Chromium picolinates, acetylacetone chelates, and other chromium complexes were studied for radiochemical syntheses. Work with mercury compounds is discussed briefly. (C.O.)

27627 THE EFFECT OF HIGH TENSION ON X-RAY TUBE AND OF SELECTIVE FILTRATION OF RADIATION ON THE QUALITY OF THE IMAGE IN ROENTGENOGRAPHY OF THE LUNGS (EXPERIMENTAL INVESTIGATION). Vinner, M. G.; Korobov, V. I.; Zilbert, E. P. (Sverdlovsk Inst. of Research of Tuberculosis, USSR). Vestn. Rentgenol. Radiol.; No. 6, 70-7(Nov-Dec 1969). (In Russian).

Balls made of wax placed against the background of various phantoms and of the chest were used to evaluate the performance of x-ray equipment for lung radiography. It was established that roentgenography with hard rays (120 kV) considerably increased the incidence of detection of the test objects, especially when a brass filter was used. Roentgenography with hard rays offers a possibility of reducing the radiation dose two and a half times, in comparison with those used in conventional roentgenography; when a brass filter was employed the integral dose was reduced 10 times. (auth)

27628 A STUDY OF CLINICAL APPLICATION WITH ^{198}Au IN THE MALIGNANT TUMORS OF THE ORAL REGION. Noikura, Takenori (Kagoshima Univ., Japan). Kagoshima Daigaku Igaku Zasshi; 21: 25-58(Jul 1969). (In Japanese).

Metastases of lymphatic system of the malignant tumors in the oral region were studied by ^{198}Au colloid scintiscanning. The relation between the scintigram and the condition of cervical lymph nodes or the clinical findings on metastatic lymph nodes was investigated and then inquiries were made concerning the change with time of cervical lymphatic flow before and after various treatments. In addition, using dogs, the cervical lymph nodes were excised on one side and, by using lymphangiography, the weekly change of lymphatic flow after the excision was investigated. The results are as follows: The scintigram of cervical region by injecting ^{198}Au colloid showed that results corresponded well with the localization of lymph nodes, but it was difficult to reveal the findings on all the lymph nodes. The lymph nodes needed to be bigger than a certain size (over 0.5 cm in diameter) in order to be recognized in scintigram, so that the more normal the lymphatic tissue was, the more clearly the picture was observed. Diagnosis of metastatic lymph nodes requires caution enough not to make a hasty conclusion from the clinical findings and scintigram only, because the metastatic lymph nodes were either utterly unrecognizable or a rough spotty picture only was recognizable in scintigram. Concerning the change with time of lymphatic flow before and after various treatments, the difference was distinctly observable in scintigram in the treatments of the primary tumor, when the ^{60}Co radiation was applied and when Ra needle was implanted. That is, in the Ra needle implanted case, the decrease of ^{198}Au colloid uptake to lymph nodes was observed for a while after the implanting and this phenomenon was caused, it seems, by damage of lymphatic nets at the implanted parts owing to the radiation. While in the case of neck dissection, the lymphatic flow on the operation side was completely blocked except in the case of partial neck dissection, and lymphatic flow was seen on the opposite side, a compensatory increase of lymphatic flow being observable. In animal experiments, a week after the excision the appearance of newly created lymphatic vessels was discernible at the submandibular part of the operation side, which did not exist before the excision. Two weeks after the operation the above new vessels reached near the median line and in three weeks developed into perfect lymphatic vessels that, passing from the submandibular part of the operation side, and through the floor of mouth, reached the submandibular part of the opposite side, and in four and five weeks, as the time elapsed, the new creation of lymphatic vessels reaching the opposite side was more and more markedly discernible. (TSS) (NSA of Japan)

27629 RADIOISOTOPIC DIAGNOSTICS. Saito, Hiroshi (Nagoya Univ., Japan). Rinsho Byori; 17: 781-89(Oct 1969). (In Japanese).

The significance of the medical application of radioisotopic diagnostics (RI) and various clinical tests using RI are discussed and the development of RI is briefly outlined. The clinical tests discussed include: cerebrovascular circulation tests with ^{85}Kr or ^{133}Xe; brain tumor scanning with ^{203}Hg-chlormerodrin, $^{99m}TcO_4$ or ^{68}Ga-EDTA; thyroid gland function tests; parathyroid function tests using ^{45}Ca or ^{47}Ca and parathyroid tumor scanning with ^{75}Se-methionine; pulmonary circulation tests and cardiac vulvular function tests with ^{131}I-MAA; myocardial tests with ^{131}Cs; RISA tests for endocardial blood volume and cardiac output; blood volume determination with RISA or ^{51}Cr-labeled erythrocyte; determination of erythrocyte life spans using ^{51}Cr, ^{14}C-glycine or ^{59}Fe; hematopoietic function tests with ^{59}Fe; iron absorption and excretion tests; the Schilling test for the measurement of vitamin B_{12} absorption; quantitative measurements of the loss of serum proteins; calcium metabolism tests with ^{45}Ca or ^{47}Ca; liver scanning; radioimmunoassay of insulin and pancreas scanning using ^{75}Se-methionine; spleen scanning with ^{203}Hg-MHP; kidney function tests with ^{131}I-Hippuran and scanning with ^{203}Hg-chlormerodrin. (NSA of Japan)

27630 THE CLINICAL APPLICATION OF RADIOISOTOPE ^{85}Sr INTO BONE TUMORS. Nishikawa, Kansuke (Chiba Univ., Japan). Chiba Igakkai Zasshi; 45: 157-86(May 1969). (In Japanese).

Linear scanning and area scanning of benign and malignant bone tumors with ^{85}Sr were studied and compared to x-ray, histological, and biochemical techniques. Remarkable ^{85}Sr uptake by epiphysis and metaphysis was observed in four normal cases. Benign bone tumors, such as exostoses, nonosteogenic fibromas, bone cysts, and chondroblastomas, showed no increase in ^{85}Sr uptake, whereas most of the benign osteoblastomas and giant cell tumors showed an increase in ^{85}Sr uptake. Strontium-85 uptake increased in various degrees in osteogenic sarcomas. Increase in ^{85}Sr uptake is recognized in most chondrosarcomas. The increase in ^{85}Sr uptake, whether in benign cases or in malignant ones, is closely related with osteoid tissue, new bone formation, and calcification. What is considered significant in the application of diagnosis of malignant bone tumors is the confirmation of tumor tissues in a case where ^{85}Sr uptake recognized in more proximal parts than in x rays. Therefore, ^{85}Sr scintigraphy is important in determining the level of amputation. In an early case where no change is recognized in x rays, the remarkable increase in ^{85}Sr uptake offers a favorable prospect for the early diagnosis of malignant bone tumors. (TSS) (NSA of Japan)

27631 LIVER SCANNING, WITH SPECIAL REFERENCE TO ^{99m}Tc. McConnell, V. A.; Saunders, S. J.; Werner, I. D. (Univ. of Cape Town). S. Afr. Med. J.; 42: 1259-61(1968).

The uses of ^{99m}Tc and rose bengal ^{131}I in the isotopic scanning of the liver are compared, and experience with 127 liver scans using ^{99m}Tc is presented. (Excerpta Med.)

27632 RADIOISOTOPE RENOGRAPHY IN CHILDREN. NORMAL AND PATHOLOGICAL FINDINGS. Swyngedauw, J.; Fontaine, G.; Sulman, C. Sem. Hop. Paris; 45: 719-38(1969). (In French).

Practical details of radioisotope renography in children, using ^{131}I-labeled hippuran, are reviewed. Radioactivity was assessed in the vessels, calyx, and parenchyma. Delayed transit, parenchymatous stasis, and reduced hippuran affinity in the parenchyma were associated to define a series of pathological tracings. Radioisotope scans in 20 children with acute or chronic glomerulonephritis and pure or complicated nephrotic syndrome were compared to adult scans. In many cases, the tracing was modified, which suggests concomitant tubular lesions. A correlation between clinical course, histological appearance, and the radioisotope scan was apparent. Renography thus seems to be a good method of following up glomerular disease in childhood; the dose of radiation used is so small that the examination can safely be repeated. (TSS) (Excerpta Med.)

27633 RELIABILITY OF ROENTGEN DIAGNOSIS. Pietilae, Kari. Duodecim; 86: No. 2, 72-4(1970). (In Finnish).

The factors affecting reliability of roentgen diagnosis are discussed. A certain amount of thorax roentgen pictures has been examined twice by the same persons, differences in diagnosis made by the same person were 32%. The pertinence of diagnosis is discussed in roentgenography of ulcer, stomach neoplasms, large intestine neoplasms, and kidney neoplasms, and in hysterography. (PS)

27634 A NEW METHOD FOR DETERMINATION OF THE RESIDUAL URINE. Gasteyer, K. H. Urologe; 7: 333-4(1968). (In German).

A method is described for the determination of residual urine using radioisotopes. Following an injection of ^{131}I-labeled hippuric acid and its nephrographic phase, the γ radiation over the urinary bladder is measured before and after spontaneous micturition. A simple formula determines the amount of residual urine. The range of error is small and the results are sufficiently accurate for clinical use. Advantage of this method lies in the avoidance of urethral catheterization. (Excerpta Med.)

27635 FIRST EXPERIENCE WITH RADIOACTIVE MERCURY (^{197}Hg) IN PULMONARY SCINTIGRAPHY. Williot, J.; Costenoble, A.; Priest, R. Acta Tuberc. Pneumol. Belg.; 59: 434-44(1968). (In French).

Preliminary results of lung scintigraphy with radioactive mercury in lung cancer are discussed. This new method seems to be effective, but requires further development. (Excerpta Med.)

27636 BRAIN SCANS WITH ^{99m}Tc (PERTECHNETATE) IN CHILDREN. Arumugasamy, N. (Northwestern Univ., Chicago). Med. J. Malaya; 23: 110-14(1968).

Substance and method employed in brain scanning at the Children's Memorial Hospital are described. Some positive scans are reproduced to attest to the degree of efficacy in the localization of certain lesions. Brain tumors, arteriovenous malformations, infarctions, septic or otherwise, and subdural membranes show the best pickup. It is hoped that brain scanning in children will be more widely used in the future as a screening device prior to angiography or other contrast studies. (Excerpta Med.)

27637 SEARCH FOR SKELETAL METASTASES WITH ^{85}Sr. Conte, G.; Vangelista, R.; Calzavara, F. (Univ., Padua). Quad. Radiol.; 34: No. 1, 43-50(1969). (In Italian).

Some technical observations are made on how this investigation may be carried out, and the results are described in 19 patients with malignant neoplasia, in whom the presence of osseous metastases had previously been demonstrated. In 12 of these, scintigraphic examinations confirmed the presence and site of the lesions already ascertained radiographically, while in five, previous diagnoses of benign lesions were confirmed. Advantages of the technique include early diagnosis and precise definition of the process, which aids in planning of radiotherapy. (Excerpta Med.) (TSS)

27638 ROENTGENOLOGIC DETERMINATION OF CALCIUM CONCENTRATION OF SKELETAL BONE WITH DOUBLE-BEAM APPARATUS. Aastrand, K.; Ahlberg, N. E.; Bartley, O.; Chidekel, N. (Sahlgrenska Sjukhuset, Gothenburg, Sweden). Acta Radiol., Diagn.; 8: 479-96(1969).

A new method of estimating the calcium content of skeletal bone with a polychromatic roentgen source and two photo-multipliers is described. The error of method was estimated in model experiments to be less than 1 per cent. Preliminary measurements in the distal half of the human radius indicate that the calcium content can be determined with a reproducibility error of ±1 per cent (95 per cent confidence level). (Sweden)

Radiotherapy

Refer also to abstracts 27445, 27589, 27619–27622, 27666, 27709, 27710, 27713, and 27714.

27639 RADIOTHERAPY IN BLADDER CANCER. Torretta, A. (Univ., Turin. Ospedali Riuniti, Trieste, Italy). Minerva Med. Giuliana; 9: 251-61(Nov-Dec 1969). (In Italian).

A description of bladder neoplasia classification criteria and the TNM is followed by an account of metastases in relation to the stage and primary site of such tumors. Anatomical and pathological criteria are also explained and emphasis is laid on the importance of histological malignancy. Simple papilloma is initially benign but must be rated as malignant for the often demonstrable presence of highly undifferentiated cells in its deeper zones. Forms with low histological malignancy are more common in the initial infiltration stages, those with high malignancy in the more advanced. Reference is made to interstitial isotope therapy with radon-labelled gold seeds, ^{198}Au pellets and wires, ^{182}Ta and ^{192}Ir wires, or ^{60}Co sources in nylon tubes, and to endocavitary treatment with labelled Na, Br, CoCl, colloidal Au and Ir, or ^{60}Co beads. Note is also taken of transcutaneous radiotherapy, including the technical advantages and improved results given by high-energy methods, especially telecobalt-therapy. An account of ^{60}Co radiation characteristics is given and the stages in the preparation of a treatment plan (assessment of body profile, localisation and centralisation of neoplastic site, and transverse section dose distribution evaluation) are explained. Immediate and long-term (mean survival to 5 yr in 20% of cases) results are good when telecobalt-therapy is made the basic form of management. Extensive, almost always inoperable, bladder tumors are best treated with high-energy radiation, particularly with ^{60}Co. Interstitial and endocavitary management is best reserved for diffuse superficial forms, while conservative surgery is indicated for very superficial, restricted area forms, which can, of course, be followed up with postoperative transcutaneous irradiation. (auth)

27640 DESTRUCTION OF THE HYPOPHYSIS BY INTERSTITIAL IRRADIATION (REVIEW OF THE LITERATURE). Lyass, F. M. Vop. Neirokhir.; 33: 52-6(Mar-Apr 1969). (In Russian).

Methods and radiation sources for radiosurgical treatment of the pituitary by transfrontal, transnasal-transphenoidal, and transetmoidal-transphenoidal are briefly reviewed. (R.V.J.)

27641 CHROMOSOME STUDIES ON PATIENTS WITH POLYCYTHAEMIA VERA. Nagy, G.; Yurgutis, R. P. (Internal Medicine Univ., Debrecen, Hungary). Haematologia (Budapest); 2: 179-86(1968).

Chromosome studies were performed on nine patients with polycythemia vera in exacerbation and in three patients with

secondary myelofibrosis developing after polycythemia vera. As compared to the normal picture, no chromosome aberrations were found in the first group of patients. In one patient of the second group, aneuploidity was demonstrated in the majority of metaphase cells. No chromosome aberrations suggesting radiation damage were found. (Excerpta Med.)

27642 RESULTS OF THE IRRADIATION THERAPY FOR ESOPHAGEAL CANCER IN OUR DEPARTMENT. Shinohara, Shinji; Ito, Yuji (Kagoshima Univ., Japan). Kagoshima Daigaku Igaku Zasshi; 21: 245-56(Sep 1969). (In Japanese).

The results of the cobalt-60 teletherapy of esophageal cancer in our department for 6 years from Jan. 1962 through Dec. 1967 were reviewed. (1) Total cases of esophageal cancer dealt with during this period were 188. In these cases, 44 cases were treated with more than 4,000 R of the tumor dosage by means of simple tele-cobalt therapy. (2) 33 of these 44 cases could be followed up and were classified according to the TNM stage classification of esophageal cancer. A vast majority of these cases were classified as advanced stage. (3) One year crude survival rate of these 33 cases was 24% and mean survival was 7.9 months. 20 of 33 cases were treated with more than 6,000 R of the tumor dosage and its one year crude survival rate was 40% with mean survival of 9.4 months. These results were approximate as compared with other author's reports. (4) No significant correlation between extent of radiographic improvement of the lesion and survival was noted. Because the results of irradiation therapy of esophageal cancer have been discouragingly poor, it should be emphasized that radiologists should strive to obtain the better results under the excellent therapy-planning. (auth)

27643 INTERRELATIONSHIP OF CHEMOTHERAPEUTIC AGENTS AND RADIATION THERAPY IN THE TREATMENT OF CANCER. Proceedings of the Fourth Annual San Francisco Cancer Symposium, October 18-19, 1968. Frontiers of Radiation Therapy and Oncology, Volume 4. Basel: S. Karger AG (1969). 208p. $16.30. (CONF-681078).

Abstracts were prepared for nineteen separate papers in this report. (H.B.G.)

For abstracts of individual papers see: 27618-27622, 27644-27653, 27665-27667, and 27701.

27644 RADIOTHERAPY PLUS CHEMOTHERAPY: HAVE WE GAINED ANYTHING BY COMBINING THEM IN THE TREATMENT OF HUMAN CANCER. Berry, Roger J. (Churchill Hospital, Oxford). Front. Radiat. Ther. Oncol.; 4: 1-16(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

The addition of chemotherapy to radiotherapy in the treatment of human cancer was discussed. The experience gained generally suggested that some increased effects upon tumors can be achieved at the expense of the increased complications due to the treatment itself. The application of the investigative techniques of radiobiology and laboratory oncology already suggested ways in which certain drugs should not be used, either alone or in combination with radiations. Some current suggestions for the more useful combination of radiations and drugs in attempting the cure of localized tumors are based on accumulation of a greater proportion of tumor cells than cells of normal tissue in a radiosensitive phase of the intermitotic cycle by suitable application of a metabolic blocking agent followed by irradiation; selective sensitization of tumor cells by agents that are incorporated only at one phase in the cell cycle, making use of the large difference between the lengths of the cell cycle in many tumors and the normal tissues from which they originated; and maximizing tumor shrinkage by early recognition and destruction of cells eventually destined to die, as an adjunct to attempted ablation of a localized tumor (by allowing reoxygenation of hypoxic tumor cells) and as a means for improving symptomatic remission in the palliative treatment of large disseminated tumors. (auth)

27645 SOME PRINCIPLES FOR A RATIONAL, CELL-BASED DEVELOPMENT OF COMBINED RADIATION-DRUG THERAPY. Elkind, M. M. (National Cancer Inst., Bethesda, Md.). Front. Radiat. Ther. Oncol.; 4: 76-8(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

The principles for combined cancer treatment of radiation and chemotherapy are outlined. During its cycle each cell undergoes several phases. Sensitivity to radiation and to various drugs reaches a maximum at phases that are characteristic for each agent. The most effective treatment combines radiation and chemicals in such a way that all phases of the cell cycle are affected. (H.B.G.)

27646 THE TREATMENT OF SQUAMOUS CELL CARCINOMA OF THE HEAD AND NECK WITH COMBINED METHOTREXATE AND IRRADIATION. Friedman, M. (New York Univ., N. Y.). Front. Radiat. Ther. Oncol.; 4: 106-15(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

One hundred and four patients with squamous cell carcinomas of the head and neck received methotrexate either orally, 7.5 mg daily for 7 to 14 days, or intravenously, 25 mg every third day for a total of five doses. Following methotrexate administration, x radiation was given in 3600 rads over three weeks. The number of favorable responses, although small, suggested further investigation of the combination therapy. (H.B.G.)

27647 USE OF METHOTREXATE AND RADIATION THERAPY FOR ADVANCED CANCER OF THE HEAD AND NECK. Kramer, S. (Jefferson Medical Coll. Hospital, Philadelphia). Front. Radiat. Ther. Oncol.; 4: 116-25(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

The combined treatment of methotrexate and radiation for advanced head and neck cancer is discussed and evaluated based on seven years of clinical experience. An objective judgment of the value of such combined therapy will have to await the result of the clinical trial now in progress. (auth)

27648 COMBINED INTRA-ARTERIAL INFUSION AND RADIOTHERAPY FOR TREATMENT OF ADVANCED CANCER OF THE HEAD AND NECK. Jesse, Richard H. (Univ. of Texas, Houston). Front. Radiat. Ther. Oncol.; 4: 126-31(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

Forty-eight patients with squamous cell cancer of the head and neck were treated by intra-arterial methotrexate or 5-fluorouracil in conjunction with a therapeutic dose of radiation therapy. In 38 previously untreated patients, local control of the cancer for 15 months was secured in 14.3% of those receiving methotrexate and 45.8% of those receiving 5-fluorouracil. Six of the 38 patients were still alive when exposed to a mean followup of 42 months. Seven of ten previously treated patients survived 15 months free of local cancer, four of whom are still alive at a mean followup of 48 months. (auth)

27649 CLINICAL STUDIES OF 5-FLUOROURACIL AS ADJUVANT TO RADIOTHERAPY. Vermund, H. (Univ. of California, Irvine); Gollin, Frank F.; Ansfield, Fred J. Front. Radiat. Ther. Oncol.; 4: 132-58(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

Since 1959, prospectively randomized clinical trials were conducted on the use of 5-fluorouracil as a chemotherapeutic adjuvant to radiotherapy of inoperable bronchogenic carcinoma, advanced carcinoma of the oral cavity, oral pharynx, laryngopharynx, nasopharynx and paranasal sinuses, glioblastoma multiforme, advanced carcinoma of the bladder, Stage II and inoperable cancer of the breast, Stage IV cancer of the ovary, and Stage III cancer of the uterine cervix. It was found that improved local tumor control and increased survival of patients with cancer of the oral cavity and oropharynx after treatment with 5-FU intravenously and irradiation is indicated. The results in bronchogenic carcinoma are still equivocal. Negative results were obtained in carcinoma of the breast, bladder, laryngopharynx, uterine cervix and in glioblastoma multiforme. It was suggested that intra-arterial infusion of 5-FU is of value in advanced oral cancer by reducing the bulk of tumor and promoting healing of ulcerations, but no prolongation of life was demonstrated in a small heterogeneous group of head and neck tumors. (auth)

27650 BILATERAL RETINOBLASTOMA COMBINED TREATMENT WITH IRRADIATION AND CHEMOTHERAPY. Tapley, Norah Du V. (Univ. of Texas, Houston). Front. Radiat. Ther. Oncol.; 4: 159-63(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

Retinoblastoma patients with moderately extensive disease received 3,500 rads over three weeks. Megavoltage radiation was preferred because of its well defined beam, limited side scatter, and decreased bone absorption. Patients with large tumors received a total dose of 4,500 rads combined with intra-arterial administration of 3-ethylenemelamine. Overall mortality was approximately 15%. Whether or not the combination therapy proved superior to radiation alone was not ascertained. (H.B.G.)

27651 ACTINOMYCIN D AND RADIATION THERAPY IN THE TREATMENT OF WILMS' TUMOR. Lemerle, J.; Schlienger,

M.; Schweisguth, O. (Inst. Gustave Roussy, Villejuif, France). Front. Radiat. Ther. Oncol.; 4: 181-6(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

One hundred thirty-one cases of Wilms' tumor were treated over 6 years (1960/66) with Actinomycin D in addition to surgery and irradiation. Ninety-three children were treated entirely by the Institut Roussy team, and most of them received pre-operative radiotherapy; surgery was followed by a single course of Actinomycin D. Postoperative irradiation was not systematic. Sixty-one per cent of these children were cured. In a previous series of 98 cases treated without Actinomycin D, the cure rate was 34%. Seventy-six children were treated for metastases, half of them having been referred to us only at that time. Twenty-two per cent were cured. Abdominal metastases have very poor prognosis. Complications related to treatment were reviewed, and the average good tolerance of Actinomycin D was noted. It is emphasized that the comparatively good prognosis of Wilms' tumor is a reason to try to spare harmful therapeutic agents such as radiations, whenever there is not a good indication for them. (auth)

27652 CONCEPTS IN THE TREATMENT OF WILMS' TUMOR. Maier, John G.; Aarestad, Norman O. (Walter Reed Army Medical Center, Washington, D. C.). Front. Radiat. Ther. Oncol.; 4: 187-94(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

In the last twenty years, 61 consecutive patients with Wilms' tumor (nephroblastoma) of the kidney have been treated at Walter Reed General Hospital. The survival rate for 53 patients, followed over a minimum period of two years, was 51%. Prior to 1960 the primary treatment was nephrectomy and postoperative irradiation. After 1960 Actinomycin D was used in addition in the immediate postoperative period. Patients were retrospectively staged with regard to extent of tumor involvement. All patients with one exception in Stages I and II survived a minimum period of two years whether Actinomycin D was administered or not. However, in Stage III patients the two-year survival increased from 15% to 36% with the addition of Actinomycin D. There was also a gain in survival time in patients who died from tumor when Actinomycin D was administered. Actinomycin D was not given prophylactically after the initial course, but only for tumor recurrence either with or without concomitant irradiation as the cases dictated. In view of the unknown long-term consequences of Actinomycin D, especially with regard to effects on gonads and bone growth, and the excellent cure rate in Stages I and II with nephrectomy and postoperative irradiation, it is recommended that therapeutic or prophylactic use of Actinomycin D be confined to Stage III Wilms' tumor patients. (auth)

27653 COMBINED CHEMOTHERAPY AND IRRADIATION IN EWING'S SARCOMA. Johnson, Ralph E. (National Cancer Inst., Bethesda, Md.). Front. Radiat. Ther. Oncol.; 4: 195-202 (1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

Lewis lung sarcomas were transplanted into the thigh of mice. Within 12 days, the tumor had widely metastasized and spread to the lungs. One group of animals received a single dose of 4000 R x radiation to the primary tumor on day 12 following inoculation. A second group was treated like the previous one but received cyclophosphamide on day 18 following transplantation. A third group received cyclophosphamide alone. Cures, defined as 90-day survivors free of tumor, were obtained only by the combination of local x radiation with systemic chemotherapy. Clinical studies were performed on patients with Ewing's sarcoma. Combination treatment of radiotherapy and chemotherapy was applied and the results evaluated. (H.B.G.)

27654 CILIARY BODY IRRADIATION WITH FAST ELECTRONS IN THERAPY-RESISTANT APHACIC GLAUCOMA. Genee, E.; Weitzel, G. Ber., Deut. Ophthalmol. Ges.; 69: 387-91(1969). (In German).

Thirteen patients suffering from glaucoma, who were treated previously unsuccessfully by various methods, were exposed to electron radiation. Electrons with an energy of 4.5 MeV were produced by a betatron. A special collimator shaped the beam half-moon like. The beam was directed toward the ciliary body. The administered dose amounted to a total of 1000 rads of which more than 80% were absorbed by the ciliary body. About four months after radiation treatment, the intraocular pressure began to fall and reached normal values in most cases. (H.B.G.)

Radiation Effects on Animals

Refer also to abstracts 27325, 27532, 27546, and 27619.

27655 (AD-699247) RELATIVE BIOLOGICAL EFFECTIVENESS OF RADIATIONS (SELECTED CHAPTERS). Darenskaya, N. G.; Koznova, L. B.; Akoev, I. G.; Nevskaya, G. F. Translated from pp 57-69; 139-68; 329-55; 356-75 of Otnositelnaya Biologicheskaya Effektivnost Izluchenii. Faktor Vremeni Oblucheniya, Moscow, 1968. 93p. (FTD-MT-24-171-69). CFSTI.

A number of general regularities in relative biological effectiveness and the factor of exposure time for various types of radiations are given. There is a definite interdependence between physical (peculiarities of interaction of various types of radiations with tissues, levels of doses and dose rates, linear loss of energy) and biological (level and tempo of physiological and reparational regeneration, nature of radiation injury) factors in the realization of an effect from exposure to radiation. A review of the literature, both Soviet and others is presented in the book. Only the following three main divisions are included in the translation: relative biological effectiveness of β radiation from various radioactive substances and fast electrons of various energies; comparative characteristics of the relative biological effectiveness of various forms of radiation; and general regularities of relative biological effectiveness and exposure time factor. (auth)

27656 RESTITUTION OF BLOOD FORMING STEM CELLS FOLLOWING X IRRADIATION. Hernadi, Ferenc; Kovacs, Peter; Daroczy, Attila (Medical Univ. of Debrecen, Hungary). Kiserl. Orvostud.; 21: 574-80(Dec 1969). (In Hungarian).

The repopulation of blood-forming stem cells, after a 150 rad whole-body irradiation, was examined in mice using stem cell-kinetic methods. The four stem cell-kinetic methods used gave results that were similar, although not completely identical. An over-compensation was noted only with the polycythemic-erythropoietin method and with the tail covering-endorepopulation method. Each of the four methods compared appeared to be suitable not only for following the restitution of stem-cell populations but also for an examination of the pharmacological substances influencing the restitution. (JPRS)

27657 EFFECT OF IRRADIATION ON THE TRANSFORMATION OF RAT PERIPHERAL BLOOD LYMPHOCYTES STIMULATED WITH PHYTOHEMAGGLUTININ IN VITRO. Karanovic, D.; Karanovic, J. Bull. Boris Kidric Inst. Nucl. Sci., Biol.; 20: No. 3, 21(Oct 1969).

The effect of x rays and phytohemagglutinin (PHA) on the transformation of circulating rat lymphocytes in vitro was investigated. At the same time, the effect of serum from the irradiated animals on the same process in culture medium was studied. Lymphocytes and serum donors were exposed to doses of 200 and 1,000 R. The results obtained showed that the first dose was of no effect and the second reduced the transformation to 50% of the normal value in the presence of normal serum in the culture medium. When the serum from animals irradiated with the same doses as lymphocytes was added to the culture medium, the level of the cell transformation was of normal value after 200 R, but after 1,000 R no survival of cells was observed. Serum from animals irradiated with 200 or 1,000 R did not affect the process of blastic transformation in normal lymphocyte cultures. In PHA cultures of the irradiated lymphocytes, the number of macrophages was increased depending on the doses. (auth)

27658 IRRADIATION OF DIFFERENTIATING MOUSE OOCYTES. Slizynski, B. M. (Inst. of Animal Genetics, Edinburgh). Curr. Mod. Biol.; 3: 35-8(Oct 1969).

A period of high sensitivity to irradiation occurs in the female mouse at the end of the third postnatal week. It coincides with nuclear changes, which suggested that structural alterations induced in chromosomes by radiation during the sensitive period could be localized. Treatment of oocytes in the ovary of 16- to 18-day-old females with 20 R of x radiation resulted in a variable number of precocious diakineses and metaphase plates in the oocytes of many embryos derived from the irradiated ones. Induction of identical mutations in the DNA/rRNA apparatus is suggested as a tentative explanation. (auth)

27659 STUDIES ON THE MECHANISM OF THE STIMULATORY EFFECT OF LETHALLY IRRADIATED CELLS ON TUMOR INOCULA. Yatvin, Milton B.; Crouse, Deborah T.; Clifton, Kelly H. (Univ. of Wisconsin, Madison). Proc. Soc. Exp. Biol. Med.; 133: 1123-8(Apr 1970).

Addition of lethally irradiated cells or nuclei prepared from them to tumor inocula increased the frequency of tumor takes and decreased latency and host survival in mice. In previous studies, sonication of either cells or nuclei abolished this effect. It was postulated that the stimulatory effect is caused by the transfer of nutrients from the membrane-bound structures in the lethally irradiated preparations to living tumor cells prior to the establishment of a vascular supply. In the current studies it was

found that sonication of ^{75}Se-methionine-labeled lethally irradiated cells or nuclei resulted in a more rapid disappearance of radioactivity from the site of injection and reduced the uptake of the label into simultaneously injected viable tumor cells. Similarly, tumors developing from inocula containing sonicated ^{125}IUdR-labeled irradiated cells retained less radioactivity than tumors which developed from inocula containing unsonicated lethally irradiated cells. (auth)

27660 ELEKTROMAGNITNYE POLYA I ZHIVAYA PRIRODA. (Electromagnetic Fields and Living Organisms). Presman, A. S. Moscow; Izdatel'stvo Nauka (1968). 288p.

Separate abstracts were prepared for five sections of the book. A review is presented of theoretical and experimental data on effects of electromagnetic fields of various frequencies on organisms of various types from single cells to man. The effects were analyzed for possible use in agriculture and medicine. Electromagnetic fields and cosmic ray effects were compared. The effects of electromagnetic fields on malignant tumors and on organisms during radiation sickness were also studied. (C.O.)

For abstracts of individual sections see: 27590, 27591, 27595, 27661, and 27707.

27661 CONCLUSION OF THE PART "PHYSICAL PRINCIPLES AND EXPERIMENTAL TECHNIQUES OF THE INVESTIGATION OF BIOLOGIC EFFECTS OF ELECTROMAGNETIC FIELDS." pp 77-9 of Elektromagnitnye Polya i Zhivaya Priroda. Presman, A. S. Moscow; Izdatel'stvo Nauka (1968). (In Russian).

Electromagnetic fields can regulate the behavior and the vital processes of organisms, or they can interfere with them. Assuming that natural, periodically changing, electromagnetic fields have a synchronizing effect on living organisms, the irregular changes (like those produced by solar flares) should be considered as interferences disturbing the regulatory systems of biological processes. Artificial electromagnetic fields, which normally differ in frequencies from natural fields, can supply wrong information to the regulatory systems or disturb the regulatory functions as noise. Experimental data prove that the sensitivity of living organisms to static fields and to electromagnetic fields of various frequency ranges is much higher than could be predicted. Apparently the laws of interaction between the electromagnetic fields and matter are not valid for living organisms, because they are equipped with some systems that are highly sensitive to electromagnetic fields. These systems and their mechanisms can be discovered only through biologic investigation, some results of which are described in the second and third part of this book. (JPRS)

27662 KINETIC ASPECTS OF MOLECULAR AND CELLULAR RADIATION EFFECTS WITH SPECIAL REFERENCE TO REPAIR AND RECOVERY PROCESSES. Hug, O. (Univ., Munich. Gesellschaft fuer Strahlenforschung, Munich). Atomkernenergie; 15: 59-63(1970).

Any quantitative analysis of the biological effects of ionizing radiation must take into consideration, from the very beginning, the kinetics of living organisms and the processes induced by radiation. Reversible and irreversible changes may take place in any state of development, beginning with the absorption of radiation energy up to the final biological effect. Each radioinduced state is characterized by buildup and decay rates. The recovery processes counteracting the radiation effects are as follows: Physico-chemical recombinations at the molecular level occurring in non-living as well as in living systems; intracellular repair processes occurring in living systems only under expenditure of energy including DNS repair, recovery from premutational damage, healing of chromosome breaks, recovery of radioinduced disturbances of metabolism and cell permeability, elimination and substitution of damaged molecules in the course of the physiological molecular turnover, Elkind's intracellular recovery phenomena, recovery from mitotic inhibition, all processes that are completed within at least 24 hours after irradiation; regeneration of cell populations in vitro and in vivo in the course of physiological cellular turnover or compensatory repopulation; general recovery phenomena of the organism as a whole under the influence of hormonal and neural feedback mechanisms. A kinetic model of the action of ionizing radiation that includes the dynamic state of living systems and radioinduced changes and their repair on the various levels of action is discussed. The classical target theory that actually is a static model is a limiting case in the framework of this proposed general theory. Certain biological effects can already be interpreted quantitatively on this basis. The model is especially valuable for understanding the role of the time factor in biological radiation effects. (auth)

27663 DYNAMICS OF THE CHANGE IN THE OSMOTIC STABILITY OF THE LEUKOCYTES UNDER NORMAL CONDITIONS AND IN EXPERIMENTAL RADIATION SICKNESS. Loginova, T. G. (Military-Medical Academy, Leningrad). Radiobiologiya; 10: 70-3(Jan-Feb 1970). (In Russian).

Changes in the osmotic stability of the leukocytes (OSL) were studied in healthy and irradiated rats in the summer and winter, one and three days and two months after irradiation. It was established that the OSL of healthy rats differed substantially at different times of year; its background in the winter was substantially below the background in the summer. One day after irradiation, the OSL did not deviate from the original level, and only on the third day was it sharply reduced. Two months after irradiation, the OSL was not restored to the original value, but had a tendency to decrease. (tr-auth)

27664 OBSERVATIONS ON THE CELL DEATH IN EMBRYONIC CELL CULTURES SUBJECTED TO THE DIRECT ACTIVITY OF ULTRAVIOLET RAYS. NOTE I. Deleanu, M. Stud, Cercet. Embriol. Citol., Ser. Embriol.; 6: No. 1, 7-9(1969). (In Rumanian).

Anomalies of cell movement, emission of clear pseudopods, pycnosis of the nucleus, paranuclear vacuoles, protuberances in the cell membrane were recorded in irradiated cultures. No intracytoplasmatic necrospherules nor any phenomena of self lysis were noted. Radiation effects were felt differently in the blastoderm necrotic focus of the tissue culture. (Rom. Sci. Abstr.)

27665 RADIOCHEMOTHERAPY OF CELL CULTURES CONTAINING CYCLING AND NON-CYCLING CELLS. Hahn, G. M. (Stanford Univ., Calif.). Front. Radiat. Ther. Oncol.; 4: 17-23(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

Chinese hamster cell cultures were treated either with bromodeoxycytidine, or methyl methane sulfonate, or x radiation, or a combination of all three. Studies of the cultured cells comprised both the exponential and the plateau phase of growth. Response to chemical agents and to radiation exposure depended on the physiological state of the cells. It was concluded that non-cycling cells were killed preferentially by monofunctional alkylating agents, while cycling cells were especially sensitive to halogenated pyrimidine in conjunction with x radiation. (H.B.G.)

27666 SPLEEN COLONY STUDIES OF LEUKEMIA L1210. VII. COMBINED EFFECTS OF HYDROXYUREA (NSC 32065) AND γ-RADIATIONS ON IN VIVO SYSTEMS. Wodinsky, I. (Arthur D. Little, Inc., Cambridge, Mass.); Swiniarski, J.; Kensler, C. J. Contract PH-43-65-61. Front. Radiat. Ther. Oncol.; 4: 79-92(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

The antileukemic activity of hydroxyurea and γ radiations alone and in combination on transplantable leukemia L1210 cells was examined in vivo by the spleen colony and host survival assays. Hydroxyurea, when administered in a single dose, reduced the surviving leukemic colony-forming fraction in the femur to a minimal achievable level at high doses (22% at 500 mg/kg, 20% at 1000 mg/kg) and was not dose dependent. The increase in life span of leukemic mice treated as above was ~20% and higher doses produced no further increase. Giving smaller effective doses more frequently potentiated the antileukemic activity of the drug. The leukemic colony-forming cells were reduced to less than 0.01% and the life span of leukemic mice was increased to 104% above untreated leukemic control mice. Total-body γ radiation (^{60}Co source) administered in a single dose produced an exponential decrease of the surviving leukemic colony-forming unit (CFU) fraction per femur with increasing doses, e.g., 25%, 1.8%, 0.1% and <0.01% of untreated controls at 200 rads, 400 rads, 600 rads, and 800 rads respectively. The increases in mean life span (ILS) of leukemic mice were 16%, 48%, 76%, and 104% respectively and reflected the decrease in the systemic leukemic population. The correlation coefficient between the surviving leukemic fraction per femur and the surviving systemic population in the host was 0.99. (auth)

27667 MODIFICATION OF RADIATION EFFECTS IN THE MURINE CENTRAL NERVOUS SYSTEM BY OXYGEN AND ACTINOMYCIN D. Zeman, Wolfgang (Indian Univ., Indianapolis. Brookhaven National Lab., Upton, N. Y.). Front. Radiat. Ther. Oncol.; 4: 93-100(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

Delayed radionecrosis of the murine spinal cord is modified by normobaric hyperoxygenation. Damage to the gray matter becomes minimally but definitely enhanced, yet the response on

white matter remains unaltered. The pattern of acute interphase cell death of murine Purkinje cells is modified by Actinomycin D given at the time of exposure or shortly thereafter. It is concluded that a combination of hyperoxygenation, with the aim to increase radiosensitivity of poorly oxygenated neoplastic cells, and Actinomycin D that should reach neoplastic tissue but not the normal nervous parenchyma, might enhance the radiovulnerability of neoplasms without commensurately increasing the risk of damage to the surrounding brain tissue. (auth)

Invertebrates

Refer also to abstract 27607.

27668 INFLUENCE OF THE COMBINED EFFECTS OF ROENTGEN-RAYS AND HIGH TEMPERATURE ON THE PROCESS OF CROSSING OVER IN DROSOPHILA. Sinkha, Suresh P. Issled. Genet.; 3: 53-62(1969). (In Russian).

Combined effects of high temperature and x rays on the recombination frequency in two different types of Drosophila with high and low frequency of spontaneous crossing-over were studied in order to determine the causes of the interlinear variability. Data obtained revealed that the effect of high temperature on two lines of heterozygous females, the mature Magarach flies and D-18 Drosophila melanogaster, increased the frequency of crossing-over in the progeny 6 to 7 days after laying. Irradiation with 2000 R also increased the crossing-over frequency after 6 to 7 days. However, this increase was observed in the Magarach line up to the 11th day and in D-18 up to the 14th day. Comparative studies of both lines revealed that the Magarach line of Drosophila was highly radioresistant, while D-18 line was more radiosensitive. (R.V.J.)

27669 INVESTIGATIONS INTO THE X-RAY-INFLUENCED RADULA-REPLACEMENT IN THE NAKED SNAIL LIMAX FLAVUS L. Kerth, Klaus; Krause, Gerhard (Univ., Wuerzburg, Ger. Heiligenberg-Instituts, Ger.). Wilhelm Roux' Arch. Entwicklungsmech. Organismen; 164: No. 1, 48-82(1969). (In German).

The naked snail, Limax flavus L. has a radula with longitudinal rows of uniform teeth with a gradually changing form toward the radula's edge in regular succession. The individual tooth sits on the front part of a basal plate. This lies on the radula membrane. The radula is continuously sloughed off at its front and is continuously renewed at the rear by an epidermal fold of the mouth cavity. This fold contains large secretion cells that represent adontoblasts. Radiation doses from 800 to 130,000 R of x radiation show increasing effects on the pattern of tooth formation. Head shielding of the snail prevents radiation damage. (H.B.G.)

Vertebrates

Refer also to abstract 27507, 27522, 27524, 27525, 27527–27531, 27533–27535, 27538–27540, 27544, 27545, 27550, 27551, 27553, 27568, 27575, 27608–27610, 27612–27615, and 27618.

27670 (AD-699127) PERFORMANCE OF MONKEYS AFTER PARTIAL BODY IRRADIATION. Thorp, J. W.; Germas, J. F. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Nov 1969. 17p. (AFRRI-SR-69-18). CFSTI.

Fifteen male and fifteen female monkeys (Macaca mulatta) were trained by shock avoidance conditioning to work a visual discrimination problem. Each animal received a 4500-rad midline tissue dose of pulsed mixed gamma-neutron radiations; of each sex, five were head-shielded, five were trunk-shielded, and five were not shielded. The midline tissue dose behind the shield was less than 8 percent of midline tissue dose to the same point without the shield in place. Postirradiation performance was evaluated. Early performance decrement occurred after irradiation in all unshielded monkeys. Either trunk shielding or head shielding decreased the probability of performance decrement. However, among the shielded monkeys that did suffer an early decrement, the head-shielded subjects recovered sooner than the trunk-shielded subjects. (auth) (USGRDR)

27671 (AD-699129) PERFORMANCE OF MINIATURE PIGS AFTER PARTIAL BODY IRRADIATION. Thorp, J. W.; Chaput, R. L.; Kovacic, R. T. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Dec 1969. 18p. (AFRRI-SR-69-20). CFSTI.

Thirty-two miniature pigs were trained by shock avoidance conditioning to traverse a two-chambered shuttlebox. Eight unshielded pigs (whole-body exposed) received midline tissue doses (MTD) of about 13,000 Rads of pulsed, mixed gamma-neutron radiations to the head and trunk. Eight head-shielded and eight trunk-shielded pigs received doses to the unshielded part of the body that were equivalent to the doses received by unshielded animals. Four trunk-shielded pigs received 6000 Rads to the head, and four others received 3000 Rads to the head. MTD behind the shield (at the middle of the head or trunk) was less than 7% of the MTD to the same point without a shield in place. Postirradiation performance was evaluated. All unshielded pigs suffered early transient incapacitation (ETI) or immediate, permanent complete incapacitation (PCI); several early deaths (within 4 hours) occurred among these animals. Head shielding prevented ETI, immediate PCI, and early deaths, but trunk shielding did not. However, trunk-shielded subjects that escaped the early death performed and survived longer than most head-shielded or unshielded pigs. ETI occurred in all of the trunk-shielded pigs that received 6000 Rads and in one of four that received 3000 Rads; however, early deaths did not occur and survival times were much longer than those previously reported for unshielded pigs that received comparable doses. (auth)

27672 (ANL-7615, pp 116-20) STRAIN DIFFERENCES IN THE RESPONSE OF THE MOUSE SKELETON TO EXTERNAL BETA IRRADIATION. Simmons, D. J.; Hakim, R.; Cummins, Helen (Argonne National Lab., Ill.).

Irradiation of mice with external ^{90}Sr-^{90}Y applicators provides a way to control the dose rate and time of exposure of the skeleton and other tissues to β rays. Therefore, toxicity information may be obtained that is impossible to resolve by the use of internal emitters. This investigation concerns the skeletal changes that were produced by preliminary exposures of three strains of mice to body surface doses of 5000 to 7200 Rads. Several strain differences in response were found. (auth)

27673 (CONF-691001) PROCEEDINGS OF CONFERENCE ON INHALATION CARCINOGENESIS HELD OCTOBER 8-11, 1969, GATLINBURG, TENN. AEC Symposium Series 18. (National Cancer Inst., Bethesda, Md. Oak Ridge National Lab., Tenn.). Apr 1970. 524p. Dep. CFSTI.

Separate abstracts were prepared for seven papers. One paper appeared in NSA previously. Twenty-one additional papers are included in the proceedings. These include papers on chemical definitions of inhalation hazards, experimental respiratory tract carcinogenesis in relation to inhalation exposures, and equipment and procedures. Other papers not within the scope of NSA were presented in the sessions on inhalation technology, cellular and functional injury following inhalation exposure, respiratory carcinogenesis, current studies in inhalation carcinogenesis, and summary and program planning. A list of participants and an index are provided. (C.O.)

For abstracts of individual papers see: 27509, 27601, 27674–27677, and 27703.

27674 (CONF-691001-, pp 285-303) LUNG CANCER: DOSE RESPONSE STUDIES WITH RADIONUCLIDES. Sanders, C. L. Jr.; Thompson, R. C.; Bair, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The induction of pulmonary carcinogenesis after deposition of radioactive particles depends on the amount and distribution of radiation dose in the lung. Nonuniform irradiation of the lung from radioactive particles is more carcinogenic than external irradiation. Similarly, for deposited particles, alpha irradiation is more carcinogenic than beta irradiation. Point-source radioactive implants produce a high incidence of lung cancer. The doses required for a substantial tumor incidence are very high, when measured in proximity to the radioactive particle(s). A model is derived that purports to estimate the carcinogenic risk associated with the inhalation of variously sized and activated particles from uranium-fueled reactors. Although the model establishes no threshold dose for carcinogenesis, it does provide an estimate of potential lung cancers that may result from deposition of single, large, radioactive particles. (61 references) (auth)

27675 (CONF-691001-, pp 305-20) EFFECTS OF CHRONIC EXPOSURE TO ARTIFICAL SMOG AND CHROMIUM OXIDE DUST ON THE INCIDENCE OF LUNG TUMORS IN MICE. Nettesheim, P.; Hanna, M. G. Jr.; Doherty, D. G.; Newell, R. F.; Hellman, A. (Oak Ridge National Lab., Tenn.).

Specific-pathogen-free C57BL/6 mice, pretreated with 100 R of whole-body x radiation and/or infected with PR8 influenza virus, were placed in inhalation chambers and exposed to either ozonized gasoline or an insoluble chromium oxide dust. The main findings were: male mice had a significantly higher incidence of lung tumors than females; irradiation raised the incidence of lung tumors in females but not in males; chronic exposure to ozonized gasoline increased the lung tumor incidence in both sexes; infection with PR8 influenza virus appeared to retard lung tumor growth; exposure to chromium oxide dust had no discernible effect on lung

tumor incidence. The only lung tumors observed during the course of these experiments were adenomas and adenocarcinomas. Under the experimental conditions used, the combination of treatments had no additive or potentiating effects. (auth)

27676 (CONF-691001-, pp 321-51) STUDIES IN PULMONARY CARCINOGENESIS. Laskin, Sidney; Kuschner, Marvin; Drew, Robert T. (New York Univ., N. Y.).

Epidemiological and experimental evidence has increasingly indicated that the interplay of multiple environmental factors is responsible for the induction of lung cancer. Man is exposed to a complex mixture of potentially hazardous materials, including specific carcinogens, and a variety of agents that may modify the manner in which the lung handles inhaled materials or responds to them. This laboratory has a program to isolate and identify these environmental factors and to evaluate their effects. Bronchogenic carcinoma, histologically similar to that seen in man, was successfully produced in high incidences in this program. The techniques involved inhalation exposures with rats, surgically implanted intrabronchial pellets in rats and hamsters, surgically implanted threads in rats and mice, and intratracheal intubations in hamsters. Dose-response relations for the induction of squamous cell carcinomas in rats were developed from the intrabronchial pellet technique with both polycyclic hydrocarbons and ionizing radiation (^{32}P or ^{106}Ru). Compounds of chromium were, for the first time, demonstrated to be capable of producing bronchogenic carcinoma of the lungs in experimental animals. Of a special interest in this study is the production of both squamous cell carcinomas and adenocarcinomas, correlating with human findings. Inhalation of benzo[a]pyrene in combination with exposure to sulfur dioxide resulted in the production of squamous cell carcinomas. These findings are of particular significance since both materials were implicated in community air pollution problems and since these represent the first duplication of human lung cancer in animals by inhalation exposures to polycyclic hydrocarbons. (auth)

27677 (CONF-691001-, pp 429-32) PATHOLOGICAL EFFECTS IN THE RAT AFTER REPETITIVE EXPOSURE TO $^{152-154}Eu$. Berke, H. L.; Deitch, D. (Wayne State Univ., Detroit, Mich. Dept. of Occupational and Environmental Health).

Female Sprague-Dawley rats were given $^{152-154}Eu$ by inhalation at levels ranging from 0.71 to 31.0 x 10^{-6} μCi/ml air to test the carcinogenic potential of inhaled beta-gamma emitters. Animals were exposed repetitively, 7 hr a day, 5 days a week for 24 weeks. Serial sacrifices were made for activity and dose determinations and the rats were observed grossly and histopathologically. Data for activity concentration after exposure and cumulative radiation dose of retained isotope are illustrated graphically. None of the animals, including those exposed to stable europium and those controls breathing room air only, were completely free of pulmonary pathology. A large number of fibroadenomas of the skin were found; some of these were thought to be of mammary gland origin and were benign. Considerable severe chronic inflammatory changes and lung abscesses were found in both the exposed and control group, suggesting the presence of communicable respiratory infection. The complete absence of pulmonary neoplasms is noted and discussed in relation to the relative effectiveness of beta-gamma emitters in tumor production when given in aerosol form. (C.O.)

27678 (EUR-4465) MEASUREMENTS OF ABSORBED DOSES DUE TO EXPOSURE OF ORGANS OF DIFFERENT COMPOSITION TO FAST NEUTRONS OF DIFFERENT ENERGIES. Final Report. Broerse, J. J.; Barendsen, G. W. (Gezondheidsorganisatie TNO, Rijswijk (Netherlands). Radiobiologisch Instituut). 18 Apr 1969. 28p. Dep. CFSTI (U. S. Sales Only). EUR FF 5.60.

The absorbed dose in cells exposed to fast neutrons depends on their atomic composition and on the composition of the materials surrounding the cells. Large dose variations may therefore occur at the interface of different tissues. The perturbations of secondary particle equilibrium at such interfaces were investigated with an ionization chamber and a cell culture system. In view of the complex character of the energy dissipation by fast neutrons, the variations in absorbed dose and in biological damage were first studied for the most extreme situations; i.e., cells adjacent to material containing no hydrogen at all or material containing the maximum amount of hydrogen which is found in some mammalian tissues. However, in the irradiation of an intact animal the variations are smaller. In subsequent experiments the variations in absorbed dose and biological effects, resulting from the same exposure, were studied for cells directly adjacent to bone and for cells surrounded by soft tissue. For x-irradiations and 15 MeV neutron irradiations survival curves have been determined for cells irradiated on muscle-equivalent plastic and on bone-equivalent plastic. These results were related to the occurrence of the bone-marrow syndrome and the intestinal syndrome in mice after neutron- and x-irradiation. (auth)

27679 IS THERE AN OPTIMAL STAGE FOR THE INDUCTION OF CLEFT PALATE IN THE MOUSE? Gebhardt, D. O. E.; Schade, G. J. (National Inst. of Public Health, Utrecht. University Hospital, Amsterdam). Cleft Palate J.; 6: 373-80(Oct 1969)

Whether various teratogenic agents have to be applied during the same or during different periods of pregnancy to induce cleft palate in the mouse was investigated. The optimal stage for the induction of cleft palate by x rays or cyclophosphamide was the eleventh and twelfth day and by dexamethasone and 6-aminonicotinamide the thirteenth and fourteenth day of pregnancy. This difference made it plausible that the critical period for the induction of cleft palate depends on the nature of the teratogenic agent. Neither dexamethasone, 6-aminonicotinamide, nor x rays induced more clefts in male than in female embryos. These agents exerted their teratogenic effect only if they were applied long before the closure of the palate. (auth)

27680 THE EFFECTS OF X-IRRADIATION, APPLIED IN INFANCY TO THE HEAD REGION, ON THE REPRODUCTIVE SYSTEM OF FEMALE RATS. Martinovitch, P. N.; Ivanisevic, O. K.; Martinovic, J. V. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Experientia; 26: 95-6(15 Jan 1970).

The head region of eight day old female rats was irradiated with whole-body x-ray doses ranging from 400 to 800 rads. Puberty occurred at the same time as in controls. Although some animals that received high doses looked weak, had a small head, and produced small amounts of milk, the reproducibility and litter size were normal. The oestrus cycle was regular. Some of the corpora lutea in the irradiated animals exceeded controls in weight. (H.B.G.)

27681 CHANGES IN THE ELECTRICAL CHARACTERISTICS OF THE SKIN AFTER EXPOSURE TO LASER RADIATION. Sidorik, E. P.; Danko, M. I.; Nikitchenko, V. V. (Kiev Scientific Research Inst. of Experimental and Clinical Oncology). Vrach. Delo; No. 10, 136-7(1969). (In Russian).

Some electrical parameters of the skin (specific resistance, dielectric constant and impedance) were studied in hamsters 1 to 14 days after exposure to a neodymium laser (100 Hz to 100 kHz). In the given frequency range, a clear-cut relation was found between the above parameters and the frequency of the alternating current. There was also a definite correlation between these parameters and the degree of skin injury. The changes in the parameters were greatest 24 hr after exposure (24-fold decrease in specific resistance at the low frequencies, 3.6-fold increase in the dielectric constant at the low frequencies but almost no change at the high, 3.4-fold decrease in impedance at the low frequencies and 4.6-fold decrease at the high). Morphological examination showed injuries to the skin to be most pronounced at this time. The electrical characteristics of the skin returned to normal 14 days after irradiation. (JPRS)

27682 EFFECTS OF FRACTIONATED IRRADIATION (3 x 200 R) ON THE PHAGOCYTIC FUNCTION OF THE RES IN STARVED RATS. Antonijevic, Milos. Bull. Boris Kidric Inst. Nucl. Sci., Biol.; 20: No. 2, 9-15(May 1969).

By means of carbon clearance test, the phagocytic function of the RES was studied in starved rats (4-day starvation) after exposure to ^{60}Co γ radiation at single dose of 600 R and fractionated doses of 3 x 200 R spaced at 10-day intervals. The phagocytic ability was followed in the acute and postacute radiation period for 4 months. In the acute period, a certain difference in the behavior of the global phagocytic index was observed that was considerably increased in starved rats irradiated with a single dose of 600 R and at the level of the control values with a slight decrease at 24 hours and an increase on the 10th day after administration of accumulated dose of 600 R (3 x 200 R). In the postacute period, the effect of single and fractionated irradiation was the same, since an increase in the phagocytic activity was stated in both cases. (auth)

27683 LASER-INDUCED PATHOLOGY OF THE RABBIT RETINA: COMPARISON OF THREE RADIATION WAVELENGTHS. Kent, Paul R.; Spencer, James A. E.; Smithwick, Grover A.; Zglobicki, Louis (Naval Submarine Medical Center, New London, Conn.). Amer. J. Optom.; 46: 847-54(Nov 1969).

Since laser radiation consists of essentially parallel rays, the wavelengths to which the ocular media are relatively transparent are focused by the eye at or near the fundus, greatly concentrating the energy in the process. Because retinal damage can result, the differential effects in respect to wavelength and power levels are of considerable importance. In this study, damage to the rabbit retina was induced by irradiation with neodymium, ruby, and frequency-doubled neodymium lasers. The neodymium laser (wavelength 1,060 nm) produced the smallest lesions and least damage. The ruby (694.3 nm) and frequency-doubled neodymium (530 nm) lasers caused lesions similar in size and seven-day

post-irradiation histopathology except for interlayer adhesion differences. (auth)

27684 ANTILOCALIZATION OF CANCER CELLS INJECTED IN IRRADIATED AREA OF RATS. Kahn, Reuben L., Verly, Gerard; Miller, Norman S.; Pressoir, Raymond; Buggs, Charles W. (Howard Univ., Washington, D. C.). Proc. Soc. Exp. Biol. Med.; 133: 1453-5(Apr 1970).

Walker 256 tumor cells were injected subcutaneously in an x-irradiated area of the right hip of Sprague–Dawley rats and in a corresponding nonirradiated area of controls. The tumors which developed in the injected areas were much larger in the controls than in the irradiated animals. The tumors were heavily encapsulated by fibrous tissue in the controls, but with little or no encapsulation in the irradiated animals. More viable cells and necrosis were present in the tumors of the controls. Special characteristics of the irradiated animals and not of the controls were invasiveness of the tumor and the presence of metastases. (auth)

27685 INFLUENCE OF ULTRAVIOLET IRRADIATION ON TRANSCRIPTION. Mant'eva, V. L.; Arion, V. Ya. Mol. Biol. (USSR) (Engl. Transl.); 3: 231-7(Mar-Apr 1969).

The effect of 2537-Å uv irradiation on the intracellular synthesis of different types of RNA was studied. On the basis of the target theory, it was expected the principal phenomenon would be inhibition of the synthesis of giant polycistron chains and thus a relation of the predecessor-type between the different RNA fractions would be found. The results showed that uv irradiation (1000 to 2000 erg/mm^2) leads to inhibition of RNA synthesis in cells of Ehrlich's ascitic carcinoma of mice. Synthesis of all types of nuclear RNA (ribosomal RNA, metabolically stable D-RNA, and metabolically labile D-RNA) is inhibited and there is a decrease in chain length. The hybridizability of R-RNA and labile D-RNA, newly formed after uv irradiation, with DNA is about 3 times that of the corresponding RNAs isolated from normal cells. An explanation of the results, based on an analysis of the structural organization of the transcription unit of R-RNA and D-RNA in the animal-cell genome, is proposed. It is suggested that a substantial portion of the repeated DNA sequences is not involved in transcription under normal conditions. These DNA sequences are activated and incorporated into RNA synthesis when the latter is suppressed. As a result, they make a greater contribution to the composition of the newly formed D-RNA. This in turn leads to an increase to the hybridizability of the latter. In this case, the repressed repeated sequences need not have absolutely the same base sequence as the working sequences. (auth)

27686 THE EFFECT OF X-IRRADIATION AND BERYLLIUM NITRATE UPON IMPLANT-INDUCED SUPERNUMERARY LIMB FORMATION IN THE NEWT. Carlson, B. M. (Univ. of Michigan, Ann Arbor). Oncology, 24: 31-47(1970).

In an experimental system of frog kidney implant-induced supernumerary limb formation in the newt, two inhibitors of limb regeneration, x rays and beryllium nitrate, were individually applied to either the frog kidney implants or to the host limb. Kidney implants irradiated with 2,220 R or 3,000 R induced normal percentages of supernumerary limbs whereas normal implants placed into limbs previously irradiated with 2,000 to 4,000 R did not stimulate any supernumerary growth. Implants soaked in N/7 beryllium nitrate for two min stimulated normal percentages of supernumerary growth, but, when normal implants were placed into beryllium-treated limbs, no regenerative response was noted. Neither x irradiation nor beryllium nitrate inactivate the factor in frog kidney that induces supernumerary limb formation. When host limbs were treated with these inhibitors, dedifferentiation was blocked and a regenerative response did not occur despite the presence of an adequate stimulus in the form of the kidney implant. It is concluded that these inhibitors disrupt some phase of the process occurring between the initial stimulus and the onset of overt dedifferentiation. (auth)

27687 IMPAIRMENT OF HEMATOGENESIS IN DOGS IN THE CASE OF A NONUNIFORM TOTAL RADIATION INFLUENCE. Kalandarova, M. P.; Savchenko, N. Ya. (Inst. of Medicobiological Problems, Moscow). Radiobiologiya; 10: 137-8(Jan-Feb 1970). (In Russian).

A comparative study of hemograms and myelograms indicated the identity of the processes occurring in the system of hematogenesis of dogs in the case of uniform and nonuniform (the coefficient of drop in tissue doses was 4) total x irradiation. The rapidity of destruction of the bone marrow, the degree and periods of a substantial decrease in the number of reticulocytes, lymphocytes, and the total number of leukocytes in both cases (MALD dose) can serve as a distinct index of the severity of radiation sickness. (tr-auth)

27688 PECULIARITIES OF THE HIGHER NERVOUS ACTIVITY OF DOGS CHRONICALLY IRRADIATED AT AN EARLY AGE BY INCORPORATED RADIOPHOSPHORUS. Chervinskaya, A. F. (Rostov-on-Don State Univ., USSR). Radiobiologiya; 10: 59-64(Jan-Feb 1970). (In Russian).

The influence of chronic internal irradiation with small doses of radiophosphorus, ^{32}P, on the higher nervous activity of dogs after the administration of this isotope at an early age, was studied. The peculiarities of the state of the processes of excitation and internal inhibition among the irradiated animals and differences in the degree and nature of disturbances of the conditioned reflex activity as a function of individual radiosensitivity were demonstrated. The long-term effects of irradiation were followed. (tr-auth)

27689 CHANGE IN THE MIGRATIONAL ACTIVITY OF THE LEUKOCYTES IN DOGS WITH ACUTE RADIATION SICKNESS. Vinogradova, V. G. (Military-Medical Academy, Leningrad). Radiobiologiya; 10: 65-9(Jan-Feb 1970). (In Russian).

The results of a differential study of the influence of total irradiation of dogs (at $LD_{99/45}$) on the migrational activity (MA) of the leukocytes are presented. An inhibiting effect of the plasma of irradiated animals on the MA of the leukocytes both of irradiated and of intact animals was detected. A determination of the influence of the plasma of irradiated animals on the MA of the leukocytes of an intact donor is recommended as a method of direct indication of toxemia arising in the case of total irradiation of animals. (tr-auth)

27690 DEPENDENCE OF THE PROTECTIVE EFFECT OF HYPOXIA ON THE RADIATION DOSE RATE. Bychkovskaya, I. B.; Shiffer, I. V. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Radiobiologiya; 10: 135-6(Jan-Feb 1970). (In Russian).

The protective effect of hypoxia (7% oxygen) on the ascites form of Ehrlich's carcinoma was investigated in mice irradiated with the γ rays of ^{60}Co at a dose of 2000 R at dose rates of 12.2 and 2.0 R/min. The weight of the dense tumor that developed after transplantation of 2×10^6 ascites cells (irradiated under the usual conditions and under conditions of hypoxia) into the paw of a mouse was determined. It was found that in the case of irradiation at a dose rate of 12.2 R/min, there was a distinct protective effect of hypoxia, while in the case of a 2 R/min dose rate there was practically no effect. The data obtained confirm the dependence of the oxygen effect on the radiation dose rate (detected earlier by one of the authors according to the death rate of the animals). (tr-auth)

27691 STATE OF THE CHOLINO- AND ADRENORE-ACTIVE SYSTEMS OF THE MONKEY BRAIN DURING RADIATION SICKNESS. Khasabova, V. A. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Radiobiologiya; 10: 111-15(Jan-Feb 1970). (In Russian).

The influence of the rhythm of photostimulation of the central cholino- and adrenolytics before irradiation and at various times of development of radiation sickness on the electrical activity of the monkey brain and on the reaction of assimilation was investigated. The behavioral and electrographic responses to the substances used changed from the fourth to seventh days after irradiation and were restored on the 20th to 22nd days. (tr-auth)

27692 INFLUENCE OF IONIZING RADIATION ON THE FUNCTIONAL STATE OF THE FROG NEUROMUSCULAR SYNAPSE. Ul'yanitskaya, A. E. (Central Scientific Research Roentgeno-radiological Inst., Leningrad). Radiobiologiya; 10: 54-8(Jan-Feb 1970). (In Russian).

The irradiation of a frog neuromuscular preparation at a dose of 18 to 20 krad produced a decrease in the sensitivity of the cholinoreceptors to acetylcholine. In this case the cholinesterase activity did not differ from the norm. After irradiation at a dose of 80 krad, the cholinoesterase activity was lowered by 15.0 ± 2.6%. After irradiation at a dose of 18 krad, there was an increase in the frequency of the miniature end-plate potentials. The functional disturbances in the irradiated synapse were expressed in a decrease in the amplitude of the end-plate potentials, a more rapid development of pessimal inhibition, and the appearance of a transformation of the rhythm of the end-plate potentials at comparatively low frequencies of stimulation. Large doses of irradiation (of the order of 60 to 80 krad) frequently induced the development of a total synaptic block. (tr-auth)

27693 RADIOSENSITIVITY OF TENCH (TINCA TINCA L.) EMBRYOS AT EARLY STAGES OF DEVELOPMENT. Kulikov, N. V. (Inst. of Ecology of Plants and Animals, Sverdlovsk, USSR). Radiobiologiya; 10: 127-30(Jan-Feb 1970). (In Russian).

Several stages with increased radiosensitivity were noted against a background of a decrease in the radiosensitivity of tench embryos during development. The prelarvae that hatched from the

eggs irradiated at a dose of 250 R at the early stages of development were distinguished by an increased death rate in the subsequent period of development. Irradiation of the embryos before hatching from the eggs and immediately after hatching produced a radioprotective effect with respect to subsequent irradiation at a dose of 1500 R. (tr-auth)

27694 INFLUENCE OF IONIZING RADIATION ON THE REPRODUCTIVE ABILITY OF THE ENDOTHELIUM OF THE BLOOD VESSELS. Ivanov, Yu. V. (Inst. of Biophysics, Moscow). Radiobiologiya; 10: 124-7(Jan-Feb 1970). (In Russian).

The mitotic activity and level of chromosome aberrations in the endothelium of the large blood vessels of rabbits irradiated at doses of 500 and 950 R were investigated. Among healthy animals 0.02 ± 0.0012% of dividing cells were registered in the endothelium of the aortic arch. In irradiated rabbits, the change in the mitotic index had a definite dose characteristic. In the case of irradiation at a dose of 950 R, a short period of suppression of mitotic activity was followed by a gradual increase in the level of mitoses, significantly exceeding the corresponding values in the control. It was established that according to the criterion of chromosome damage, radiation injury to the endothelium was close to that in actively proliferating tissues. A distinct dose dependence of the increase in abnormally dividing cells was noted. (tr-auth)

27695 INFLUENCE OF IONIZING RADIATION ON THE PRESYNAPTIC TERMINALS. Mtskhvetadze, A. V. (Central Scientific Research Roentgenoradiological Inst., Leningrad). Radiobiologiya; 10: 130-2(Jan-Feb 1970). (In Russian).

The question of the nature of blocking of the transmission of impulses through the synapse under the action of radiation doses from 800 to 2500 rad was studied by comparing portions of perfusate of the upper cervical sympathetic ganglion with respect to acetylcholine content. Since it was found that stimulation of the preganglionic stem both in the control and in the experimental group induced an increased secretion of acetylcholine, it may be considered that within the indicated dose range there was probably no block in the presynaptic endings. (tr-auth)

27696 EFFECT OF FRACTIONATED IRRADIATION ON THE PERIPHERAL BLOOD OF FASTED RATS. Dragic, Marko; Ninkow, Vukosava; Karanovic, Jovo; Hajdukovic, Srdan. Bull. Boris Kidric Inst. Nucl. Sci., Biol.; 20: No. 1, 1-7(Jan 1969).

The effect of fractionated ^{60}Co γ irradiation (3 × 100 R) on counts of erythrocytes, leukocytes, and lymphocytes, hematocrit, and iron-59 uptake by erythrocytes in peripheral blood in rats previously fasted for four days was investigated. The results showed that previous starvation did not essentially change the radiosensitivity of the hematopoietic functions if the changes in the radiosensitivity of the peripheral blood induced by fractionated irradiation were considered. The changes were almost the same as those in normal rats irradiated under the same conditions. (C.O.)

27697 CIRCULATORY CHANGES IN THE MUCOSA AND MUSCULAR LAYER OF THE SMALL INTESTINE OF RATS AFTER SUPRALETHAL IRRADIATION. Zsebok, Z.; Janossy, G.; Meszaros, I. Kiserl. Orvostud.; 20: 572-9(1968). (In Hungarian).

Rats were subjected to whole-body irradiation with 1500 R, and the circulatory fractions of the mucosa and muscular layer of the small intestine were then examined by the ^{86}Rb extraction technique. The values found were considered in relation to the DNA content of the sample material. Four hours after the irradiation, the organic fraction in the mucosa was found to be increased, probably associated with the development of tissue edema. However, 24 hours later it was considerably reduced in the duodenal mucosa in relation to the tissue to be perfused, and after 48 hours also in the mucosa of the rest of the small intestine, because the capillary system was damaged less than the epithelial tissue. The phenomena described may contribute to a functional shift of the radiation damaged small intestine in the direction of transduction. (Excerpta Med.)

27698 FURTHER STUDIES ON THE RADIOSENSITIVITY OF THE RAT INCISOR. THE RELATIVE RADIOSENSITIVITY OF SUPERIOR AND INFERIOR INCISORS, AND OF LABIAL AND LINGUAL ODONTOGENETIC ELEMENTS. Koppang, H. S.; Stokke, T. (Univ. of Oslo). Odontol. Tidskr.; 77: No. 1, 47-61 (1969).

Radiosensitivity was compared in superior versus inferior incisors, and in labial versus lingual/palatinal odontogenetic (dentinogenetic) elements of incisors in 60 male rats exposed to single x-ray doses of 200, 300, 400, 500, 600, and 700 R to the head. The beam was directed laterally, to the growth center of the left incisors. The radiation constants were 175 kV, 12 mA, filter 0.5 mm Cu, diameter of the field 4 cm, TSD 24 cm, output 87.94 R/min. The animals were sacrificed after 2 weeks and the superior and inferior incisors prepared for investigation in the light microscope. The complete roentgen lesion was defined as the roentgen niche in dentine, while incomplete lesions referred to less pronounced changes. The finding indicated that the superior rat incisor must be considered more radiosensitive than the inferior one, and that labial dentinogenesis must be classified as more radiosensitive than lingual dentinogenesis. A roentgen dose of 700 R was established as necessary for the production of complete lingual roentgen lesions in superior and inferior incisors of rats. Roentgen doses of 200 R were found capable of inducing complete and incomplete labial lesions in superior rat incisors. (Excerpta Med.) (TSS)

27699 EFFECT OF INTERNAL IRRADIATION PRODUCED BY ^{198}Au INJECTIONS ON THE NEUROEPITHELIUM OF THE VENTRICULAR CAVITIES OF HEN EMBRYOS. Menkes, B.; Alexandru, C. Stud. Cercet. Embriol. Citol., Ser. Embriol.; 6: No. 1, 45-50(1969). (In Rumanian).

The pseudostratified neuroepithelium of the neural embryonic tube shows, from a functional viewpoint, several layers namely: the S layer (of DNA synthesis), I layer (interval between the DNA synthesis and beginning of mitosis) and the M layer (juxtaventricular mitoses). Injection of colloidal gold into the ventricular cavity of the mesencephalon in hen embryos on the third or fourth day of incubation induces some manifest necrotic processes in the S and I zones. Necrosis shows all the phases from necrobiosis to total disintegration of the cell. It appears that lesions induced by the radioactive gold are due to a localized irradiation and not to its toxicity. Two hypotheses of necrobioses and necroses in the S layer are advanced. An attempt is made to explain the origin of necrospherules in the M layer cells. (Rom. Sci. Abstr.)

27700 DIFFERENCES BETWEEN EXOGENOUS AND ENDOGENOUS HEMOPOIETIC SPLEEN COLONIES. Jenkins, V. K.; Upton, A. C.; Odell, T. T. Jr. (Oak Ridge National Lab., Tenn.). J. Cell. Physiol.; 73: 141-8(1969).

Histologic examination of the spleens in RFM/Un mice killed 6 to 9 days after 350 to 800 R whole-body x irradiation revealed hemopoietic colonies, the numbers of which decreased exponentially with increasing radiation dose. In such animals, myelocytic colonies were the predominant type on the sixth to eighth day. However, they decreased in number with time, being fewer than erythropoietic colonies by the ninth day after irradiation. In C57BL mice, erythropoietic colonies were relatively more numerous, markedly predominating on both the eighth and the thirteenth days. RFM/Un mice injected with nonirradiated syngeneic bone marrow cells within 24 hours after 750 R developed colonies, predominantly of erythropoietic and undifferentiated types, the numbers of which were proportional to the numbers of marrow cells injected. The number of colonies formed from exogenous marrow cells increased slightly between the sixth and ninth days after inoculation, possibly because of a greater likelihood of counting them because of an increase in their size. (Excerpta Med.)

27701 SOME EFFECTS OF RADIATIONS AND RADIATION MODIFIERS ON GROWING HAIR. PROGRESS REVIEW. Griem, M. L.; Malkinson, F. D. (Univ. of Chicago). Front. Radiat. Ther. Oncol.; 4: 24-45(1969).

From 4th Annual Cancer Symposium, San Francisco, Calif. See CONF-681078.

The hair of mice haunches was plucked and the effect of various drugs and x radiation on regrowth was studied. Local application of x radiation from 200 to 900 R produced increasingly dysplastic hairs. Hyperthyroidism, induced by triiodothyronine, increased radiosensitivity, while hypothyroidism, induced by ^{131}I, decreased radiosensitivity. If actinomycin D was administered 4 and 16 hours prior to x-ray exposure, maximum dysplasia was induced. Colchicine injected 16 hours prior to x radiation caused maximal hair dysplasia. Cysteamine hydrochloride, given 10 to 45 minutes prior to irradiation, showed a significant protective effect. Other chemotherapeutic agents were used in combination with x-ray therapy in the treatment of tumor patients. (H.B.G.)

27702 COMPARATIVE ASPECTS OF RADIO-RESISTANCE WITH DEPRESSED METABOLISM. Musacchia, X. J.; Barr, R. E. (Univ. of Missouri, Columbia). pp 569-607 of Depressed Metabolism. /Musacchia, X. J. (ed.). New York; American Elsevier Publishing Co., Inc. (1969).

From 1st International Conference on Depressed Metabolism, Washington, D. C. See CONF-680847.

The relation between the depressed metabolic state induced by hibernation and hypothermia in ground squirrels (Citellus tridecemlineatus) and by hypothermia in hamsters (Mesocricetus auratus) and survival following exposure to various doses of whole-body γ radiation was investigated in an attempt to elucidate mech-

anisms involved in the radioprotective effect observed. All ground squirrels irradiated (900 to 20,000 rads) during hibernation showed a higher level of resistance to radiation than did control animals, with the most marked protective effects noted when animals were irradiated at a body temperature of 13°C. Hamsters exposed to whole-body doses of γ radiation ranging from 500 to 3,000 rads when the body temperature was 5°C were more resistant to radiation than were normothermic controls. Changes in blood oxygen content and in liver and kidney total catecholamide (epi- and nor-epinephrine) content were investigated for their effect on radiosensitivity. No clear explanation for the radioprotective effects of hibernation and hypothermia was found. (31 references) (C.H.)

Man

Refer also to abstracts 27508, 27511, 27567, 27597, 27602, 27603, 27605, and 27616.

27703 (CONF-691001-, pp 77-101) INHALATION OF RADIONUCLIDES AND CARCINOGENESIS. Bair, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

It was not suggested until 1921 that the high incidence of lung cancer among central European pitchblende miners might be related to ionizing radiation in the mines. Arguments supporting this relation were strengthened by recent epidemiological studies that convincingly demonstrated an increased incidence of lung cancer among uranium miners of the Colorado plateau and fluorspar miners of Newfoundland, who were exposed to high levels of the radioactive decay products of radon. However, attempts to confirm the carcinogenic action of inhaled radon decay products in experimental animals have met with little success. This gave rise to the consideration that other constituents of uranium mine environments, and perhaps cigarette smoking, may be synergistically involved. Pulmonary neoplasia has been induced in experimental animals after inhalation, intratracheal deposition, or implantation of a variety of other radionuclides, including the alpha emitters ^{210}Po, ^{238}Pu, and ^{239}Pu, and the β-γ emitters ^{103}Ru, ^{106}Ru, ^{198}Au, ^{32}P, ^{59}Fe, ^{35}S, and ^{144}Ce. Studies with these radionuclides are especially relevant to the potential exposure of various segments of the human population to products of the nuclear age. Still lacking, however, is knowledge of the basic processes involved in radiation carcinogenesis, which would aid in extrapolating the results of animal experiments to man. Although inhaled radionuclides are clearly carcinogenic, much remains to be learned of their possible interrelations with other environmental factors in contributing to the human lung cancer problem. (62 references) (auth)

27704 (ORNL-tr-2296) RADIOBIOLOGICAL ASPECTS OF RADIATION SAFETY IN SPACE FLIGHTS. Grigor'ev, Yu. G.; Kovalev, E. E. Translated for Oak Ridge National Lab., Tenn., from pp 207-11 of Some Problems of Aviation and Space Medicine, Prague, 1967. 8p. Dep. CFSTI.

This paper was abstracted previously and appeared in NSA Vol. 23 as number 43787. (C.H.)

27705 SUNBURN EFFECT ON KERATINOSOMES, A REPORT WITH SPECIAL NOTE ON ULTRAVIOLET-INDUCED DYSKERATOSIS. Wilgram, George F.; Kidd, Richard L.; Krawczyk, Walter S.; Cole, Paul L. (Tufts New England Medical Center, Boston. Harvard School of Dental Medicine, Boston). Arch. Dermatol.; 101: 505-19(May 1970).

Moderate sunburn in normal whites produced a statistically significant decrease in keratinosomes in epidermal cells of the upper malpighian and the granular layer as early as two hours postirradiation. This decrease persisted up to 72 hours. At 120 hours, keratinosomes were visible again in normal numbers. Keratinosomal disappearance preceded cytoplasmic degeneration in other compartments of keratinocytes of the upper epidermis by three hours and was thus the first morphologically visible sign of epidermal cell injury after ultraviolet (uv) irradiation. It is suggested that the disappearance of keratinosomes was involved in producing further cytoplasmic alterations of epidermal cells and that keratinosomal disintegration was one of the factors in the pathogenesis of sunburn. The behavior of keratinosomes after uv injury reported here suggests that these organelles, although unique in many ways, have several features in common with lysosomes. (auth)

27706 THE INFLUENCE OF IONIZING RAYS ON THE INNER EAR. Westernhagen, B. v.; Schaetzle, W. (Univ., Goettingen, Ger.). Arch. Klin. Exp. Ohren-, Nasen- Kehlkopfheilk.; 195: 109-20(1969). (In German).

Patients that received x irradiation of the base of skull showed a combined disturbance of sound conduction and perception. Histochemical investigation of guinea pigs that received x irradiation of the skull with a tissue dose to the inner ear of 4000, 5000, and 6000 R, showed radioinduced labyrinth disturbance. Changes in activity of non-specific esterase, lipase, β-galactosidase, β-glucuronidase, β-glucosaminidase, acid and alkaline phosphatase, protein-bound sulfhydryls and acid mucopolysaccharides were studied. Enzymes at first mostly showed an increase of activity but with higher doses of radiation a decrease of activity was seen. Protein-bound sulfhydryls and hyaluronidase-sensitive acid mucopolysaccharides showed a proportionate decrease. (auth) (TSS)

27707 PHYSICAL BASES OF THE INTERACTION OF ELECTROMAGNETIC FIELDS WITH BIOLOGICAL OBJECTS. pp 43-5 of Elektromagnitnye Polya i Zhivaya Priroda. /Presman, A. S. Moscow; Izdatel'stvo Nauka (1968). (In Russian).

If the human body is considered as a uniformly conductive ellipsoidal object, the density of the induced surface change acquired in the presence of a uniform electrostatic field of voltage E when the long axis of the body is parallel to the direction of the field may be calculated from the formula, $q = (E/4\pi n) \cos \theta$, where n is a coefficient depending on the form of the ellipsoid, and θ is the angle formed by the intersection of the line of direction of the field and a line between the point of observation and the point under consideration on the body. Under these conditions the ellipsoid acquires a dipole moment which may be expressed as $p = (abcE/3n)$, where a, b, and c are the semiaxes of the ellipsoid. For spherical conductive bodies, the corresponding formulas are: $q = (3E/4\pi) \cos \theta$; $p = a^3 E$. (JPRS)

27708 DANGERS FROM THE USE OF RADIOLOGICAL DENTAL UNITS AND SOME PROTECTIVE MEASURES. Tzitzidis, St. Stomatologia (Athens); 26: 39-46(Jan-Feb 1969). (In Greek).

The radiation hazards to dentists using radiographic equipment are discussed, with emphasis on the danger of using the fingers to hold films in the mouth of patients during dental radiography. Protective measures are suggested. (C.H.)

27709 CARDIOVASCULAR COMPLICATIONS FOLLOWING RADIUM THERAPY IN GYNECOLOGICAL PATIENTS. Bianchi, F.; Pagnoni, A. (Studio e Cura Tumori, Milan). Minerva Ginecol.; 21: 215-21(1969). (In Italian).

A series of 22 cases of cardiovascular complications following radium therapy in gynecological tumor patients is reported. The results show that they were, for the most part, cases of pulmonary embolism. The relations between these complications, the case history, the stage of the tumor, the position of the radium source and the doses employed are discussed. (Excerpta Med.)

27710 THE EVALUATION OF CYTOLOGICAL RADIOSENSITIVITY TESTINGS ON THE RADIORESISTANT OF THE CANCER OF THE CERVIX UTERI. Takeuchi, Keiichi (Kanazawa Univ., Japan). Kanazawa Irigaku Sosho; No. 83, 1-21(Apr 1969). (In Japanese).

To determine whether the tumor is radioresistant or not is of high practical importance at the beginning of radiotherapy in carcinoma of the uterine cervix. Drs. Oshita and Endo have established a diagnostic criterion for radioresistant cancer by carrying out a histological study of serial biopsy from onset of radiotherapy. At the same time, the author has examined radiosensitivity of the same cancer from a cytological viewpoint. Eighty patients treated with localized radiation from small radioactive source were examined as to the relation between their 5 year survival rate and radioresistance of cancer proven histologically. That is, reliability of histological diagnosis was studied. Five year survival result of these 80 cases, treated with radiation, was 41.2% including many advanced cases. Incidence of radioresistant cancer judged from histology was 17.1%, and all patients of radioresistant cancer died excepting 2 cases which were treated with radical operation after revealing their malignancy. In a word, histological diagnosis proved very reliable. Graham's radiation response (RR) test which deduces radiation response of the host by the radiation change of benign epithelial cells showed 52.9% good RR and 47.1% poor RR in these patients; a higher percentage than that of histological study was obtained. Positive correlation was observed between these two methods concerning 5 year survival rate, for good RR was 53.2% and poor RR was 24.2%. Generally speaking, Graham's method was less reliable than the histological one, so the former is of secondary practical importance. The period necessary for the maximal radiation response was 15 days on an average. The maximal radiation response was shown after 16.2 days in the cases of poor RR and 16.6 days in the cases of non-survivors, i.e., tendency of elongation was noted. This tendency was true of the patients with worse prognosis; for example, there were no survivors in the cases which required a period over 21 days to their maximal radiation.

response. The term between the beginning of radiotherapy and disappearance of exfoliative cancer cells differed as 21.9 days in total average, 18.5 days in the survivals over 5 years, and 26.7 days in the cases of non-survivors. The term disclosed a close relation between radiosensitivity of tumor by histological judgement, for the term was 36.2 days in radioresistant cancer while 21 days in radiocurable one. An especially bad prognosis was seen in the cases in which tumor cells remained over 31 days, and mortality in five years was 13/14. From the above-mentioned results, a high reliability should be laid on the following two methods concerning diagnosis and prognosis of carcinoma of the cervix uteri, one is histological study of radioresistance and the other is a test of the period in which living exfoliative cancer cells remain. For this reason, the author recognized the clinical importance of these tests when carried out one month after the beginning of radiotherapy with small sources. (NSA of Japan)

27711 POSSIBLE INFLUENCE OF PRENATAL IRRADIATION ON THE DEVELOPMENT OF CEREBRAL ELECTRIC ACTIVITY IN MAN. Geets, Willy (Clinique Sainte Elisabeth, Brussels). Acta. Neurol. Physchiat. Belg.; 68: 654-61(1968). (In French).

Eighteen cases of children with epileptic manifestations are reported. The etiological inquiry was negative, with the exception that the mother had a history of low-dose x ray exposure during radiography of the abdomen during pregnancy. Among these 18 cases, followed for an average period of two and a half years, a slowing of the cerebral electrical activity, demonstrating an absence of maturation, was noted in 10 children aged from one to seven years. In five other cases, aged from 7 to 12 years, the electrical activity was normal at rest, but slow rhythms, paroxysmal features, or high-amplitude activities were obtained during overbreathing. This retarded electrical maturation appears in children whose intellectual development is usually normal; it seems to be only an inflection of the normal evolution of the cerebral electrical activity that eventually becomes normal. (auth)

27712 LASER-INDUCED EFFECTS ON TOOTH STRUCTURE. III. SINGLE PULSE IMPACTS ON SURFACE ENAMEL AS OBSERVED IN SHADOWED REPLICAS. Mannerberg, Fritz; Kantola, Sirkka; Scheinin, Arje (Univ. of Lund, Malmoe, Sweden. Univ. of Turku, Finland). Acta Odontol. Scand.; 27: 467-76 (1969).

Microstructural alterations in dental enamel by means of single impacts of a ruby laser were studied. The structural changes were analyzed by comparing shadowed replicas of the surface enamel prior to and after laser radiation. Dependent on the laser energy, no effects were observed except crater formation. No relation between the laser effect and the type of tooth surface could be observed. (F.F.M.)

27713 OPHTHALMOLOGIC FINDINGS FOLLOWING HIGH-DOSE TELE-GAMMA-RADIATION. CLINICAL AND HISTOLOGICAL OBSERVATIONS. Cullmann, B.; Claus, H.-G. (Johannes Gutenberg-Univ., Mainz). Arch. Klin. Exp. Ophthalmol.; 179: 82-104(1969). (In German).

Damage to the eye is frequently unavoidable following radiotherapy of periorbital tumors. The reactions of the eye to radiation were studied in 26 patients following surface-doses varying between 4320 and 14,320 R. The results were compared with the histological findings in 8 cases in which the eye was enucleated. Alterations were observed in all tissues excepting the sclera. Serious corneal changes were the most noticeable occurrences. Radiation glaucoma was very frequent. Therapeutic possibilities are limited to symptomatic treatment and are not very promising. A loss of the bulb is to be expected following exposure to more than 8000 R. (F.F.M.)

27714 HIGH SINGLE-DOSE IRRADIATION. Kaercher, K. H. (Univ., Heidelberg). Fortschr. Geb. Roentgenstr. Nuklearmed.; 110: 388-91(Mar 1969). (In German).

The limited uses of single high doses of irradiation in the treatment of malignant tumors is discussed. It is stressed that the possibility of tissue damage of normal organs must be kept in mind in order to achieve successful results. (auth)

27715 RADIOTHERAPEUTIC AND RADIOBIOLOGIC PROBLEMS OF LENS PROTECTION IN CHILDREN. Halama, J. (Ruhr Univ., Essen). Ber., Deut. Opthalmol. Ges.; 69: 209-20 (1969). (In German).

The incidence of radiation-induced cataracts is discussed for children with retinoblastomas exposed to single doses between 200 and 300 R of x radiation and fractionated doses up to 1500 R of x radiation or γ radiation. For fast electrons, sufficient data are not available. Neutron radiation has a higher incidence than x radiation or γ radiation. Problems of dose rate and fractionation are discussed. To decrease the radiation hazard, methods of eye protection, beam collimation, and sedation of patients are important factors for treatment. Problems of radon, radium, and cobalt-60 implantations are discussed as is the need for a center that supervises the best treatment method for children whose eyes are potentially exposed to radiation. (H.B.G.)

Radiation Effects on Plants

Refer also to abstracts 27541, 27570, 27572–27574, 27576, 27611, and 27660.

27716 PRELIMINARY TESTS ON THE EFFECT OF ACUTE GAMMA RADIATION OF ^{60}Co ON SUNFLOWER PLANTS. Kovacik, A.; Skalska, R. (Inst. of Genetics and Plant Breeding, Prague). Genet. Slechteni; 5: 23-8(Mar 1969). (In Czech).

The most precise of the factors studied (weight of green and dry matter, percentage of dry matter above ground and of the roots of the sunflower plant) in the determination of the radiobiological effects of ^{60}Co γ radiation on sunflower plants in the initial phases of their development and growth turned out to be the determination of the percentage weight of dry matter. The percentage weight of dry matter in both varieties studied showed that up to 30% of moisture of achenes during the radiation period and even at higher doses of acute γ radiation there was no fundamental change. At greater levels of moisture, the percentage weight of dry matter increased in direct proportion to the dose of acute ^{60}Co γ radiation already in the first stages of development and growth as a result of changes in the metabolism of the plant. (auth)

27717 INFLUENCE OF MOISTURE IN SUNFLOWER SEEDS ON THE REACTION TO ACUTE GAMMA RADIATION (^{60}Co). Kovacik, A.; Skalska, R. Genet. Slechteni; 4: 109-14(Apr 1968). (In Czech).

The reaction of sunflower plants after irradiation of seeds of different moisture content to acute ^{60}Co γ radiation was investigated. The following conclusions were drawn. The moisture of the seeds at the time of irradiation was an important factor in radiosensitivity evident from the beginning of the development and growth of sunflower plants. In the case of a high moisture content of the seeds, low doses of 500 R and, partially, also of 1000 R still exercised a stimulating effect on the development of the plants. A critical shift towards harmfulness set in in the case of an acute γ irradiation with 3000 R and of a moisture content of the seeds of from 34 to 37%. For a mutagenic effect on sunflowers, a dose of 3000 R seemed to be optimal with a moisture content of the seeds of from 30 to 40%. (auth)

27718 RADIATION EFFECT ON X-VIRUS ACCUMULATION AND POTATO DEVELOPMENT. Moskovets, S. N.; Anokhin, V. M. Mikrobiol. Zh.; 31: 47-52(Jan-Feb 1969). (In Ukrainian).

The possibility of sterilizing x-virus on potato plants by means of irradiation in the presence of other viruses of rugose mosaic was studied. A decrease of x-virus accumulation was proved at doses stimulating the growth and development of potato by γ or x rays. In comparison with the control, the virus concentration was considerably higher in plants grown from tubers treated with the doses inhibiting their growth and development. When the tubers were treated with neutrons, radiostimulation was absent, and a serological titre and infectivity of PXV (potato X-virus) were the highest. Attention was paid to the possible harmful radiogenetic aftereffects of irradiation of tubers affected by viruses as a result of increasing a natural background of potato virus mutations. (auth)

27719 DYNAMICS OF THE APPEARANCE OF RADIATION STIMULATION. Riza-Zade, R. R.; Suleimanova, N. L. (Scientific Research Inst. of Agriculture, Baku). Radiobiologiya; 10: 98-102(Jan-Feb 1970). (In Russian).

The dynamics of the external quantitative manifestation of radiation stimulation of the sunflower in the case of preplanting irradiation of the seeds with the γ rays of radioactive cesium at a dose of 2 kR was studied during the entire vegetation period. A continuous stimulation, despite its wave-like external manifestation according to individual criteria, was demonstrated. It was established that the stimulating effect of radiation was comparatively more apparent externally on the rates of occurrence of the corresponding processes of growth and development than on the final manifestation of these criteria. (tr-auth)

27720 BIOLOGICAL EFFECTIVENESS OF PROTONS AND GAMMA RAYS FOR CARROTS IN THE CASE OF PREPLANTING IRRADIATION OF SEEDS. Gertsuskii, D. F.; Alekseenko, L. V. (Inst. of Medicobiological Problems, Moscow). Radiobiologiya; 10: 94-7(Jan-Feb 1970). (In Russian).

Data are presented on the quantitative dose versus effect dependence of 630 MeV protons and the γ rays of ^{60}Co for carrots in the case of preplanting irradiation of seeds. The lethal doses of these types of radiation for the carrot according to the criteria of survival of the plants and the formation of root crops only slightly exceeded 50 krad of protons and 150 krad of γ rays. The RBE coefficient of 630 MeV protons for carrots according to various criteria can fluctuate from values less than 1 at low doses to 3 or more at high doses. (tr-auth)

27721 ULTRAVIOLET IRRADIATION OF THE VEGETATIVE CELLS OF DICTYOSTELIUM DISCOIDEUM. Freim, J. O. Jr.; Deering, R. A. (Pennsylvania State Univ., University Park). J. Bacteriol.; 102: 36-42(Apr 1970).

Experiments on the effect of ultraviolet (uv) light on the survival of vegetative Dictyostelium discoideum cells indicate that this is a relatively uv-resistant organism. Several factors suggest the presence of some type of repair process. Experiments to test for liquid-holding recovery and simple photoreactivation yielded negative results. Acriflavine and caffeine were utilized to possibly interfere with dark repair. Acriflavine produced no uv sensitization, but caffeine did cause a concentration-dependent decrease in survival of irradiated cells. When uv-irradiated cells were illuminated with photoreactivating light while suspended in caffeine, the survival increased above that for cells treated with caffeine alone, suggesting an overlap between lesions repaired by photorepair and dark repair. Growth experiments showed that uv light induced a dose-dependent division delay, followed by a period of retarded growth characterized by the presence of a constant fraction of nonviable cells in the irradiated population. The delayed exposure of cells to caffeine after irradiation showed that the magnitude of the caffeine sensitization diminished throughout the division-delay period. An action spectrum indicated probable nucleoprotein involvement in the induction of division delay. Ultraviolet light retarded ribonucleic acid and protein synthesis and temporarily blocked deoxyribonucleic acid synthesis. However, synthesis of all three accelerated prior to the end of the division-delay period and then closely paralleled the increase in cell number. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 27543, 27571, 27577, and 27718.

27722 APPARENT ABSENCE OF RELATIONSHIP BETWEEN REPAIR OF SINGLE STRAND BREAKS IN DNA AND GAMMA RADIATION RESISTANCE IN SALMONELLA THOMPSON. Allwood, M. C.; Jordan, D. C. (Univ. of Guelph, Ont.). Arch. Mikrobiol.; 70: 161-6(1970).

A mutant strain of Salmonella thompson (S. thompson/r), with an increased resistance to γ radiation, did not appear to possess a DNA repair system, active in a non-growth medium, similar to that reported for Micrococcus radiodurans and Escherichia coli B/r. DNA strand breaks occurred to a similar degree in both the sensitive parent strain and the resistant mutant strain during exposure to γ radiation. The DNA could be reconstituted in both strains, but only when the cells were incubated in a growth-promoting medium after irradiation. Results indicated that inactivation of S. thompson by γ radiation was not the result of the production of DNA single-strand breaks per se, and the resistance of the mutant strain, therefore, did not appear to be directly related to the ability to repair such breaks. (auth)

27723 INTERACTIONS IN THE RECOVERY OF SALMONELLA TYPHIMURIUM DAMAGED BY HEAT OR GAMMA RADIATION. Corry, Janet E. L.; Kitchell, A. G.; Roberts, T. A. (Meat Research Inst., Bristol, Eng.). J. Appl. Bacteriol.; 32: 415-28 (1969).

Growth of two strains of Salmonella typhimurium in nutrient broth, selenite and tetrathionate broths, at 37 and 43°, after damage by heat or γ radiation, was compared with that of undamaged cells. Counts at 37° were made on 6 media initially and after enrichment for 24, 48 and 72 h. Analyses of variance showed complex interactions of cell damage, enrichment medium, temperature and duration of enrichment, and plating medium. The most generally satisfactory combination of factors involving use of selective inhibitors appears to be enrichment in tetrathionate broth at 37° followed by plating at 48 h on brilliant green, Wilson and Blair, or brilliant green-phenol red agar. After attaining maximum numbers in 18 h in selenite broth, salmonellae died off rapidly or, if heat damaged, may fail to grow at all in this enrichment medium. Incubation at 43° in either selenite or tetrathionate medium, except after pre-enrichment, is not recommended for heat damaged salmonellae. (auth)

27724 THYMINELESS DEATH IN ESCHERICHIA COLI 15T$^-$ AND RECOMBINANTS OF 15T$^-$ AND ESCHERICHIA COLI K-12. Medoff, Gerald; Overholt, Sharon (Harvard Medical School, Boston, Massachusetts General Hospital, Boston). J. Bacteriol.; 102: 213-16(Apr 1970).

Thymineless death was examined in Escherichia coli 15T$^-$ and recombinants of 15T$^-$ and E. coli K-12. Those strains that were very sensitive to thymine deprivation were also very sensitive to a variety of inducing agents (mitomycin C, ultraviolet light, hydroxyurea, and nalidixic acid). Those strains that were relatively resistant to thymineless death were also relatively resistant to the inducing agents. After exposure to thymineless death and the inducing agents, sensitive strains lysed, produced colicin, and had phage particles in their lysates. These strains also showed an increase in the 6-methyladenine content of their deoxyribonucleic acid (DNA) and an increase in the DNA methylase activity of their crude extracts under these conditions. None of these effects was noted in the strains relatively resistant to thymineless death and the inducing agents. These data indicate that there are two types of thymineless death. One is represented by the strains that are very sensitive to thymine deprivation and other inducing agents and is secondary to the induction of phage φ. The strains more resistant to thymine deprivation and the other inducing agents undergo a non-phage-mediated thymineless death. The mechanism of this latter process is currently under study. (auth)

Radiosterilization and Radiopreservation

Refer also to abstract 27718.

27725 THE USE OF GAMMA-RADIATION FOR THE STERILIZATION OF DRESSING MATERIAL AND INSTRUMENTS. Shevchenko, I. T.; Surkov, G. G.; Boiko, L. D.; Dyul'dina, A. S.; Zver'kov, L. S. Khirurgiya (Moscow); 45: 15-7(May 1969). (In Russian).

The method of γ radiosterilization of dressing material and instruments for surgical practice and the changes occurring in the properties of antibiotics after irradiation are discussed. The effectiveness and expediency of radiosterilization in comparison with other techniques were demonstrated. An industrial device with ^{60}Co γ source of adequate capacity for the sterilization of medical articles is described. (auth)

27726 STUDIES ON THE MICROORGANISMS OF CEREAL GRAIN. PART 10. EFFECT OF STORAGE ON MICROORGANISMS ON GAMMA-IRRADIATED RICE. Ito, Hitoshi; Shibabe, Sadami (Japan Atomic Energy Research Inst., Gunma). Nippon Nogeikagaku Kaishi; 43: 773-9(Nov 1969). (In Japanese).

To observe the effect of storage at 30°C on microorganisms on rice irradiated by gamma ray, unpolished and polished rice harvested in Japan was used as the samples. The storage life of polyethylene-packed rice containing 14 ~ 15% moisture was extended by 3 to 4 times by means of 0.2 Mrad irradiation. The number of molds on the irradiated rice grains was not increased for 3 to 4 months under this condition. When the moisture in the rice sample was 17%, irradiation of more than 0.4 Mrad was necessary to extend its storage life. The species of molds that can propagate on storage-rice grains containing 17% moisture were mainly Aspergillus glaucus group and Penicillium citrinum series, whereas A. restrictus, A. versicolor, A. candidus, etc. were minor ones. When moisture content was 16%, A. glaucus group and A. restrictus were observed. Only the osmophilic type of A. restrictus propagated on the rice sample containing 14 to 15% moisture. When a sheet of porous material, e.g., craft paper bag, was used to pack rice, the storage life of rice containing the moisture of less than 15% was extended by 3 to 4 times by means of 0.2 Mrad irradiation, the storage conditions being 30°C, 75% relative humidity. In this case the number of molds on rice was not increased for 3 to 4 months under this condition. (NSA of Japan)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Corrosion and Erosion

Refer also to abstract 28982.

27727 (IS-2151) INTERNAL OXIDATION AND OXIDES OF A VANADIUM-15 TITANIUM-7.5 CHROMIUM ALLOY. Duncan, Darrel R.; Larsen, William L.; Kayser, Frank X. (Ames Lab., Iowa). Aug 1969. Contract W-7405-eng-82. 51p. Dep. CFSTI.

Sheet samples of V-15 Ti-7.5 Cr alloy were charged with oxygen by oxidizing under a reduced pressure of oxygen in the temperature range 850 to 1020°C and annealing in vacuum between 750 and 950°C. The resulting alloys were examined by metallography, x-ray diffraction, microprobe and microhardness. The single oxygen-affected surface layer observed after oxidation broadened by diffusion into two distinct zones after annealing. The outer (surface) zone was dark-etching and contained appreciable precipitate. Its hardness was approximately 500 dph as compared with an initial alloy hardness of approximately 250 dph. The inner light-etching zone contained finer precipitate, was sometimes relatively featureless in structure, contained cracks, and was hardened to 1000 dph or more. As annealing temperatures were increased the inner hardened zones disappeared and a uniformly distributed oxide was observed. This oxide was identified as $(Ti,V)_2O_3$ solid solution. In this particular alloy it had the approximate composition $(Ti_8V_8)_2O_3$. Titanium diffused outward from the unaffected core of the alloy toward the advancing oxygen front, where it precipitated internally as $(Ti,V)_2O_3$. In the most highly oxidized surface zones, all the available titanium was extracted from the alloy leaving a binary vanadium-chromium alloy matrix. Chromium apparently did not participate in the oxidation reaction to any significant degree. A computer program for the indexing and precision determination of hexagonal lattice parameters was developed. The lattice constants for the $(Ti,V)_2O_3$ found in this study were $a_0 = 5.042 \pm 0.002$Å, $c_0 = 13.933 \pm 0.004$Å. An error in the prior indexing of Ti_2O_3 was found using the present computer program. The study of alloys prepared by oxidation under a low pressure of gaseous oxygen, followed by a homogenizing anneal, appears to be useful as a way of accelerated testing and evaluation of alloys intended for use in oxygen-contaminated sodium. (auth)

27728 SOME CHEMICAL PROPERTIES OF MOLYBDENUM GERMANIDE POWDER. Popova, O. I.; Biryukova, R. S. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 3, 89-93(Mar 1970). (In Russian).

The chemical resistance of molybdenum digermanide was studied in acids of various concentrations and their mixtures, in caustic soda solutions, oxidating media, mixtures of acids with oxidizers, and complexing agents. It is shown that the $MoGe_2$ compound is not resistant to the effect of reagents possessing oxidizing properties. The resistance of molybdenum digermanide to oxygen and air was investigated. Molybdenum digermanide proved to be less resistant than molybdenum disilicide. (auth)

27729 DEPENDENCE ON TIME AND TEMPERATURE OF THE ELECTRIC RESISTANCE OF NIOBIUM DURING OXIDATION AT 10^{-5} TO 10^{-3} TORR AND 200 TO 700°C. Steeb, S.; Breitling, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Metall, 23: 1002-6(Oct. 1969). (In German).

Niobium layers evaporated in high vacuum were gassed with oxygen at 10^{-5} to 10^{-3} torr between 200 and 700°C and the electrical resistance and its temperature dependence was determined. The resistance-time curves show a continuous pattern, except for a characteristic marked off by the suboxide phases Nb_6O, Nb_4O, or Nb_2O or by the oxide phases NbO and NbO_2. This is especially remarkable as the experiments were carried out on relatively thin samples, which had the same thickness (300 Å) as samples used earlier for electron diffraction studies in which the individual phases could be detected. The time increase of the layer resistance R_t can be described by two time laws: in thick layers, low temperatures, and low gas pressures, and with long oxidation the time resistance can be expressed by a linear law of the form $R_t - R_o (1 + Kt)$; in thin layers, high temperatures, and high gassing temperatures, the resistance can be described by a logarithmic law of the form $\log R_t^2 - A + Bt$ (A and B = constants). The chemisorption process on the oxide surface was assumed as the velocity-determining step in both cases. The value averaged by plotting log R over 1/T increases the activation energy of the chemisorption with the gassing time so that a linear relation exists between the activation energy of the chemisorption and layer resistance. (tr-auth)

27730 OXIDATION OF Nb-Hf AT 600 TO 1000°C. Korobkov, I. I.; Barinov, I. P. Izv. Akad. Nauk SSSR, Metal.; No. 6, 200-4 (Nov-Dec 1969). (In Russian).

The rate of oxidation of Nb-Hf in air at 600, 800, and 1000°C is expressed in a curve with two maxima in an alloy with 5 and 90 at. % Hf and a minimum in the region of 50 at. % Hf. The properties of the oxides depend on the compositional percentages of the alloys, the thickness of the film, and the oxidation temperature. With the content of hafnium in the alloy up to 10 at. %, Nb_2O_5 was formed on the surface. With the content of hafnium from 30 to 70 at. % mixtures of Nb_2O_5 and HfO_2 formed. If the content of Hf was above 90 at. %, HfO_2 was formed, and thin oxide films had the tetragonal modification structure at 600°C. (tr-auth)

27731 INTERGRANULAR CORROSION OF ALLOYS OF THE INCONEL 600-TYPE IN WATER VAPOUR. Berge, Ph. (Electricite de France, Chatou). Corros. Sci.; 10: 185-9(Apr 1970). (In French).

By modifying the structure of an Inconel 600 alloy, it is possible to modify its corrosion behaviour in vapour at high temperature. When the carbides are precipitated out of the grain boundaries, the diffusion of chromium towards the surface follows preferably the grain boundaries and the corrosion is intergranular. A fine and regular precipitation of the carbides in the boundaries modifies completely the shape of the chromium-depleted zones and may impede intergranular corrosion in these conditions. (auth) (UK)

27732 EVALUATION AND TESTING OF ZIRCONIUM ALLOY CORROSION IN HIGH-TEMPERATURE WATER. Ryabova, L. V.; Tersin, V. A.; Rassokhin, N. G.; Gerasimov, V. V. (Inst. of Power Engineering, Moscow). Teploenergetika; No. 3, 57-8(Mar 1970). (In Russian).

Studies were made of the problems related to corrosion of Zr-Nb^1 (1% Nb) alloy in a flow of water at 270 to 290°C. (R.V.J.)

Preparation and Fabrication

Refer also to abstracts 28444 and 28660.

27733 (NP-tr-1887) THE THERMAL DISSOCIATION OF THORIUM TETRAIODIDE. Gerlach, J.; Pawlek, F.; Probst, H. Translated for Univ. of Melbourne, from J. Less-Common Metals; 14: 355-66(1968). 16p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 22: 23733 (1968). (auth) (Australia)

27734 MAGNETIC WELDING. Grin, M.; Marchal, F.; Pruess, D. (EURATOM, Ispra, Italy). Rev. Met. (Paris); 67: 125-36(Feb 1970). (In French).

The welding process uses the power produced by the discharge of a battery of high-capacity condensers; it combines the advantages of explosive welding with the ease of magnetic forming. The following examples were studied: magnetic welding of SAP (plain and fin tubes); magnetic welding of Zircaloy-2; and closing of aluminum tubes. The cost of welding is given. (auth) (France)

27735 THE TASK OF DIRECT ROLLING OF METAL POWDERS FOR FIBER METALLURGY. Visconti, I. Crivelli (Univ., Naples). Met. Ital.; 61: 550-5(Nov 1969). (In Italian).

The possibility of applying a new technique which is being used in powder metallurgy, i.e., direct rolling, to make fibrous composite metal strips is discussed. The principal parameters involved in powder direct rolling techniques are summarized, and an experimental method to determine the input angle is derived. The possibility of rolling powder and fibers, resulting in the composite strip, is then discussed in the light of the comparative importance of the single parameters. A few experimental results for the systems Al-W, Fe-W, and Fe-Mo are shown and discussed. (auth)

27736 METHOD OF PREPARING SINGLE CRYSTALS OF INDIUM ANTIMONIDE. Dashevskii, M. Ya.; Okun, L. S.; Plotkina, G. Z. (to Moscow Inst. of Steel and Alloys). Russian Patent 228,792. 7 Feb 1969. Filed 19 Jul 1966. (In Russian).

A method is presented for preparing high-alloy single crystals of InSb according to the Chokhral'skiy method. In order to prepare a concentration of electrons in ingot on the order $(1.5 \pm 0.2) \cdot 10^{19}$ cm^{-3} a doping impurity is introduced in the form of In_4SbTe_3 compound. (JPRS)

27737 2. EUROPAEISCHES SYMPOSIUM UEBER PULVERMETALLURGIE, IN STUTTGART, VOM 8. BIS 10. MAI 1968. BAND I. (Second European Symposium on Powder Metallurgy,

Stuttgart, 8–10 May 1968. Volume I). Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). 325p. (In several languages). (CONF-680504–(Vol.1)).

A total of 16 papers were presented at the conference and included in Volume I. A separate abstract was prepared for each of 6 papers. The remaining 10 papers were not within the scope of NSA. (G.M.C.)

For abstracts of individual papers see: 27738–27741, 27774, and 27840.

27738 INFLUENCE OF THE SINTERING CONDITIONS ON THE CHANGES IN THE SURFACE OF SINTERED POROUS BODIES. Angenet, R.; Rolland, P. pp 1.7.1-14 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band I. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In French).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.1).

In a study on tantalum powders for electrolytic capacitors, sintered porous anodes were prepared, and their properties related to sintering at high temperature (about 2000°C) and high vacuum. Laws governing bridging between particles, resembling spheres of the same specific surface as the powder, were applied to the initial sintering stages. This showed the importance of the Fisher sub-sieve size, which allowed evaluation of anode shrinkage and effective surface as function of compacting and sintering. The effective surface was readily calculated from capacity measurements after oxidation of the anode under known conditions. The agreement between empirical data and theoretic formulas justified the work hypothesis, at least for first stages of sintering. An interpretation strain subsists, to develop the sintering theory to the practical case of the genuine powders with large granulometric distribution. (auth)

27739 SURFACE MEASUREMENT STUDIES ON SINTERED POWDER COMPACTS. Kindl, B. pp 1.9.1-17 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band I. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.1).

The Dubinin–Radushkevic (D–R) low pressure method for the measurement of surface areas is reviewed and its applicability to powder compacts is discussed. The possibility of measuring real equilibrium pressures was examined over various powder sizes and compact densities. Because of the high reactivity toward gases of Zr-Al alloys, these were chosen to compare the value of real surface area as determined by the D-R method with a noble gas like Kr with the value as indicated by the kinetics of sorption of chemisorbed gases like N_2 and CO. The surface area determinations were applied to sintering of Zr-Al alloy powder compacts in high vacuo and in the temperature range 800 to 1200°C. The results are discussed in view of the possible sintering processes as for instance surface diffusion and bulk diffusion. (auth)

27740 THE INVESTIGATION ON KINETICS OF HOT PRESSING OF TUNGSTEN AND TUNGSTEN-BASE PSEUDOALLOYS. Pilipovskii, Yu. L.; Karpinos, D. M.; Kondratev, Yu. W.; Kovalchenko, M. S.; Shamatov, Yu. M. pp 1.21.1-23 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band I. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.1).

Kinetics and densification mechanism in hot pressing of tungsten and tungsten base alloys were investigated expertmentally. The densification occurred due to complex of mechanisms. During the initial period at the relative densities 0.45 to 0.6 the process of particle displacement and dense packing prevailed. Over the relative density interval 0.6 to 0.8 plastic deformation in contact areas dominated. At relative densities above 0.8 the diffusion at grain boundaries controlled the process. It was shown that mathematically the densification process was satisfactorily described with the mechanism of volume viscous flow of compressible liquid by Kovalchenko–Samsonov's equations. (auth)

27741 PHYSICOCHEMICAL PRINCIPLES IN THE PRODUCTION OF POWDER METALLURGY PRODUCTS WITH PREDICTED PROPERTIES. Samsonov, G. V. pp 2.1-17 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band I. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.1).

The theory underlying the production of sintered parts with preset properties is reviewed in the light of the theory and laws of the electron structure of materials. A model of the condensed state is described which is based on the special features of the electron configurations of various materials corresponding to the conception of the structure of sintered parts. This model adequately explains the influence of additions on the properties of metals and alloys. The theoretical results obtained for dispersion-strengthened materials, materials for electric contacts, and sintered cathodes, and on hard metals are checked. (auth)

27742 INFLUENCE OF DOPING ADDITIONS ON THE SINTERING BEHAVIOR OF TUNGSTEN POWDERS IN THE TEMPERATURE REGION FROM 20 TO 1100°C. Hamel, H. J. pp 3.4.1-21 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.1a).

The sintering behavior of pressed pieces of pure and doped tungsten powders was shown by the pressures in a dilatometer between temperatures of 20 and 1100°C. The dilatation of pure samples corresponded to the dilatation of a compact tungsten rod. Three different types of sintering curves were distinguished when doped tungsten powders were used. The effect of moisture during storage of the doped powders was studied. The unstable behavior of the sintering curve was removed by water leaching. Upon titrating these fluids, relations were found between the titration curves and the sintering curves. An attempt was made to explain the reactions. (auth)

27743 THERMAL GRANULATION OF METAL POWDERS. Schreiner, H. pp 4.5.1-16 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.1a).

The granulation of metal powders means a method of treating non-flowing powder in order to give it good flow properties. In the case of thermal granulation, the powder is treated in a presintering and re-grinding process. The shape, size, distribution, and structure of the powder particles are thus changed. Good flow properties of metal powders are important in the manufacture of mass-produced parts on automatic presses with controlled filling systems. Of the various granulating methods employed in powder metallurgy, the thermal granulation method has widespread application. The conditions necessary for the thermal granulation of electrolytic silver powder, CuNi 30, AgC 4, and WCu 25 Ni 5 are given. A description is given of thermal granulation with liquid phase, taking AgPb 10 as an example. Granulated powder properties such as the density ratio (apparent and tap densities), flow time, and structural composition, are given. (auth)

27744 PRODUCTION OF FORMED BODIES BY POWDER SLIP METHOD. Dobrovolskii, A. G. pp 4.6.1-16 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.1a).

The factors determining the properties of aqueous powder slips are discussed. Materials (metals, carbides, borides, silicides, nitrides, oxides) were classified according to the results of interaction of water with the acid or alkaline base. The two groups of aqueous slips were stabilized by addition of HCl or NaOH respectively. The effects of stabilization for both acid or alkaline materials and of the content of solids in slips on the density of castings were established. Thixotropy of slips, its detrimental effects on the properties of castings, and methods of avoiding it are discussed. (auth)

27745 FABRICATION AND DENSIFICATION OF POWDERS BY ACCELERATION WITH HIGH-ENERGY PULSES. Bumm, H.; Liepelt, H. pp 4.14.1-14 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.1a).

A new fabrication method is described in detail together with a specially designed electrodynamic apparatus in which the powder particles were compacted by short but rapid acceleration. The actual compacting took 1 msec at an acceleration up to 20,000 g. In spite of the very short application long cylindrical bodies could be produced with a theoretical density of 70% T. The successful use of the technique was demonstrated by high-density cylindrical specimens of oxides (Al_2O_3, UO_2), metal powders (carbonyl iron or molybdenum) and cermets (Al_2O_3-Mo-powder mixtures). Hard

and fine-grain powders (<30 μm) were particularly suitable for high densification. The processes occurring during the shock loading are described fully. (auth)

27746 DOUBLE-LAYERED SINTERED MATERIALS. Schreiner, H. pp 6.8.1-18 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band II. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2).

Double-layer sintered metals are materials, semi-products, and formed parts consisting of two sintered layers of metal powders of different composition. Although the main reasons for their introduction lie on the materials and manufacturing sides, economics also play an important role in the application of the materials. A description is given of the main variables affecting the manufacture and properties of the new metals. Descriptions are also given of such special double-layer sintered materials as $Fe^{20}Ni/Fe^{36}Ni$, Cu/Fe, $Cu/Cu^{30}Ni$, $Cu/Cu^{8}Sn$, $Ag^{8}Cu/Cu^{30}Ni$, $Ag^{10}Pb/Ag$, $Ag^{10}Pb/Fe$, $Ag^{10}Ni/Ni$, $Ag^{10}Ni/Cu$, $Ag^{10}Ni/Cu^{30}Ni$, $AgCd^{10}O/Ag$, $AgCd^{10}O/Cu$, $AgCd^{10}O/Ni$, $AgCd^{10}O^{8}Cu/Cu$, $AgCd^{10}O^{8}Cu/Cu^{30}Ni$, $Ag^{4}C/Ag^{10}Ni$, $W^{10}Cu/NiCu$, $W^{4}Ni/Ni$, and $W^{10}Ag/Ag$. The materials are used as bimetal strips, electrical conductors and contacts, and as semi-conductor components. (auth)

27747 FABRICATION AND PROPERTIES OF DISPERSION-STRENGTHENED FERRITIC STEELS. Huet, J.-J.; Massaux, H.; de Wilde, L.; Noels, J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). pp 6.22.1-21 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In French).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2a).

With a view to finding a canning material not susceptible to high-temperature irradiation embrittlement for nuclear fast reactors, dispersion-strengthened ferritic steels were studied. Fabrication problems, starting with the mixing of elementary metal powders and ceramic powders, are described. Hot extrusion was found to be an easy way of fabricating the dispersion-strengthened steels. Tensile tests at 700°C showed that the U.T.S. was improved substantially without detrimental reduction in ductility. (auth)

27748 DISTRIBUTION OF TUNGSTEN, TANTALUM, AND NIOBIUM WHEN A TUNGSTITE CONCENTRATE IS DISSOCIATED BY THE ACID METHOD. Nadol'skii, A. P.; Fedosov, V. N.; Anfilogova, L. A. Tr. Irkutsk. Politekh. Inst.; No. 47, 32-6(1969). (In Russian).

An investigation was made of the dissociation of tungsten concentrate with the following composition: WO_3–69.04%, Fe–4.94%, Mn–13.47%, SiO_2–3.62%, Ta_2O_5–0.51%, Nb_2O_5–1.03%. The reagent used for dissociation was concentrated HCl at 100°C in a two-stage reaction with subsequent lixivation by an ammonia solution. Following lixivation by the ammonia solution 98% of the tungsten passed into the ammonia solution and 100% of the tantalum and niobium remained in the residue. This residue was enriched by a factor of about 15 with respect to tantalum and niobium and may be used for extraction of these metals. This type of two-stage dissociation of a concentrate using the reaction $(Fe, Mn)WO_4 + 2HCl = H_2WO_4 + (Fe, Mn)Cl_2$ with subsequent dissolution of the H_2WO_4 in an ammonia solution provided for effective utilization of all valuable metals contained in tungsten concentrates. (JPRS)

27749 ELECTROLYTIC REFINING OF TANTALUM IN MOLTEN SALTS. Balikhin, V. S. Izv. Akad. Nauk SSSR, Metal.; No. 6, 79-84(Nov-Dec 1969). (In Russian).

The composition of the alloy melt for the electrolytic refining of tantalum was determined. Studies were made on the effects of soluble tantalum and sodium fluoride in the melt. An optimum electrolyte consisting of 65 to 50% NaCl, 15 to 30% NaF, and 20% K_2TaF_7 was recommended. The positive effects of fluoride additions on the electrolytic process showed improvement in crystalline structure of cathode precipitate, suppression of surface metallic film development, and facilitated washing of the cathode precipitate from the electrolyte. The effects of temperature on the electrodeposition of tantalum and its purity are discussed. (tr-auth)

27750 PREPARATION OF SILICIDES OF TITANIUM, NIOBIUM, AND TANTALUM BY HYDROGEN REDUCTION OF CHLORIDES. Kozlov, F. N.; Petrusevich, I. V.; Nisel'son, L. A.; Gurevich, M. A.; Khatskevich, M. M. Izv. Akad. Nauk SSSR, Metal.; No. 6, 88-91(Nov-Dec 1969). (In Russian).

The possibility of preparing silicides by hydrogen reduction of the chlorides was studied. The combinations used included $TiCl_4 + SiCl_4$, $NbCl_5 + SiCl_4$, and $TaCl_5 + SiCl_4$. Experiments were planned for the preparation of mono- and disilicides of titanium. A formula of Nb_5Si_3 was used for the preparation of niobium silicide and Ta_5Si_3 responded for the preparation of tantalum silicide. (auth) (TSS)

27751 COMPOSITE STRUCTURE WELDED WITH TUNGSTEN-CONTAINING NICKEL-BASE FILLER METAL. McCoy, Herbert E.; Canonico, Domenic A. (to U. S. Atomic Energy Commission). U. S. Patent 3,502,450. 24 Mar 1970. Filed 8 Aug 1967.

The welding of nickel-base alloys was accomplished by employing weld filler metal of the base metal and modifying this filler metal so as to incorporate a sufficient quantity of tungsten which would provide a weldment containing 0.5 to 5.0 weight per cent tungsten. The tungsten was added to the filler metal by alloying or by providing the filler metal with a coating of tungsten or a tungsten-containing material. Improved welding characteristics and weldment properties were realized by employing tungsten-containing filler metal. (AEC)

Properties Evaluations

Refer also to abstracts 27817, 27841, 27844, 27845, and 29004.

27752 (AD-700338) LOW-TEMPERATURE MECHANICAL PROPERTIES OF POLYCRYSTALLINE NIOBIUM AND MOLYBDENUM. Interim Technical Report, February 1, 1969–January 31, 1970. Shaw, B. J. (Westinghouse Research Labs., Pittsburgh, Pa.). 31 Jan 1970. Contract Nonr-4442(00). 24p. CFSTI.

The energy of twinning was found for polycrystalline niobium specimens at –196C. These results derived from dead-load tests on a modified creep machine compared with previous estimates derived from stress relaxation tests and gave an energy of the order of 10^9 ergs/cm^3. This high energy value and the metallographic features of twinning were explained in terms of a continuous nucleation theory of twinning. Initial experimental results from piezoelectric strain gauges were also given. (auth) (USGRDR)

27753 (AD-701737) THERMODYNAMIC PROPERTIES OF TERNARY REFRACTORY CARBIDES. II. ZIRCONIUM–URANIUM–CARBON. Technical Report, July 1, 1967–June 30, 1969. (Cincinnati Univ., Ohio). Dec 1969. Contract F33615-67-C-1565. 24p. (AFML-TR-69-209(Pt.2)). CFSTI.

The thermodynamic properties of ternary zirconium–uranium carbide, Zr (x)U (1 – x)Cy, having the sodium chloride-type structure were studied using the time-of-flight mass spectrometer. The ratio of the activities of the components was measured as a function of composition at 2440°K. From the variation of the ratio of activities with composition, the pairwise interaction energies were obtained. The metal-metal interaction energy = 6.7 ± 0.6 kcal/mole is similar to that in the body-centered cubic zirconium–uranium metallic system. The difference between the zirconium–carbon and uranium–carbon interaction energy is a function of composition. (auth) (USGRDR)

27754 (AI-AEC-12932) EFFECT OF HELIUM ON STRESS-RUPTURE BEHAVIOR OF TYPES 304 AND 316 STAINLESS STEELS. Garr, K. R.; Kramer, D.; Rhodes, C. G. (Atomics International, Canoga Park, Calif.). 15 Apr 1970. Contract AT(04-3)-701. 28p. Dep. CFSTI.

Flat tensile samples of Types 304 and 316 stainless steels, with helium contents of 1.5×10^{-6} and either 3.5 or 4.0×10^{-6} atom fraction, were stress-rupture tested in vacuum at 760°C (Type 304) and 700°C (Type 316). The presence of helium caused large reductions in rupture life and in elongation at failure. The amount of strain produced within the grains of helium-containing samples was a small fraction of the measured total elongation. The difference in these values was accounted for by extensive intergranular cracking. (auth)

27755 (BM-RI-7385) EVALUATION OF ELECTROWON TUNGSTEN SHEET. Keith, G. H.; Winston, J. S.; Iverson, H. G. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). May 1970. 14p.

Electrowon tungsten powders were investigated with respect to consolidation, fabrication, and mechanical properties. Sheet, 0.03 inch thick, was produced and its tensile strength measured between 250 and 1,935°C. The large particle size of electrowon tungsten effectively precluded sintering to a density sufficient to allow hot working to sheet or bar. The powders were consolidated by die pressing to 70% density, sheathing in molybdenum, and high-energy-rate extruding to either round or sheet bar of 100% density. The material was then rolled conventionally to sheet. The mechanical properties of the sheet prepared from the electrowon powders compared favorably with those reported in the literature

for sheet prepared from commercially produced hydrogen-reduced powder. (auth)

27756 (IS-Trans-81) PRECIPITATION HARDENING BY DIFFUSION IN THE STRESS FIELD OF A DISLOCATION. Gleiter, H. Translated for Ames Lab., Iowa, from Acta Met.; 16: 857-62(1968). 12p. Dep. CFSTI.

The distortion field of a dislocation has the effect that at low temperatures, where thermal diffusion is no longer possible, rapid diffusion processes occur in the vicinity of a dislocation. If precipitate particles are cut by a dislocation, this diffusion leads to the movement of atoms from the particle into the matrix and of matrix atoms into the particle. Because of this effect the critical shear stress of precipitation—hardened alloys and solid solutions was increased. The increase in shear stress, Δt, was calculated and the temperature dependence of Δt discussed. From this an explanation was deduced for the 'plateau' in solid-solution hardening. (auth)

27757 (N-70-16239) SIMPLIFIED ANALYSIS OF NUCLEAR FUEL PIN SWELLING. Lietzke, Armin F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan 1970. 43p. (NASA-TN-D-5609; E-5145). CFSTI.

The effect of fuel swelling on strains in the cladding of cylindrical fuel pins is analyzed. Simplifying assumptions are made to permit solutions for strain rates in terms of dimensionless parameters. The results of the analysis are presented in the form of equations and graphs which illustrate the volumetric swelling of the fuel and the strain rate of the fuel pin clad. (auth) (STAR)

27758 (NYO-4097-1) FATIGUE-ENHANCEMENT OF DIFFUSION. Progress Report, June 1, 1969-May 31, 1970. Herman, Herbert (State Univ. of New York, Stony Brook). Contract AT-(30-1)-4097. 15p. Dep. CFSTI.

Fatigue-enhancement of diffusion was studied in alpha-brass in the disordered condition. Diffusion in this alloy occurred by a vacancy mechanism, and when the disordered alloy was irradiated at ambient temperatures, the resistivity was seen to decrease, implying the generation of vacancies which were able to aid diffusion. Such, too, was the case for low-amplitude cyclic straining. The temperature dependency was different than for the irradiation experiments, yet the results were qualitatively similar. Recent work was aimed at elucidating a frequency and amplitude effect in cyclic straining. In addition, alpha-brass was cycled at the temperature of liquid nitrogen, followed by isochronal annealing. A study is currently underway to characterize the process which is giving rise to enhanced ordering in this latter experiment. Enhanced diffusion during cyclic straining represented the fatigue-assisted breakdown of a metastable condition (the initially disordered alloy), and therefore has important fundamental and technological implications. (auth)

27759 HOT BRITTLENESS OF MOLYBDENUM ALLOYS. Ignatov, D. V.; Kantor, M. M.; Klypin, B. A.; Morgunova, N. N. Metalloved. Term. Obrab. Metal.; No. 1, 62-5(1970). (In Russian).

An electron-microscopic study of the structure of certain molybdenum alloys was made after testing at high temperatures for the clarification of structural changes and the relation to hot brittleness. Tests conducted on two alloys (Mo with a small amount of carbon) at 1300 and 2000°C revealed hot brittleness. The degree of embrittlement depended on the chemical composition of the alloys and the rates of deformation. The electron-microscopic study showed that the hot brittleness is caused by the appearance of Mo_2C at the grain boundaries. (tr-auth)

27760 HEAT-RESISTANCE AND DUCTILITY OF Ti-Mo ALLOYS. Nartova, T. T.; Andreev, O. N. Metalloved. Term. Obrab. Metal.; No. 1, 73-4(1970). (In Russian).

Studies were made on the heat-resistance and ductility of Ti-Mo alloys containing up to 20 at. % (33 wt %) Mo in relation to their phase structure. The modulus of normal ductility and the modulus of shift of Ti-Mo changed insignificantly as a function of composition. The heat resistance increased in proportion to the increase of the content of molybdenum at 400 to 700°C. The data were used to construct the phase diagram and to establish the optimum compositions of Ti-Mo with maximum heat-resistance. (tr-auth)

27761 Zr Hf NEWSLETTER, APRIL 1970. Akron, N. Y.; AMAX Specialty Metals Division (1969). 18p.

References (232) are given to information on hafnium, zirconium metal, zirconium-base alloys, zirconium as an alloying element, compounds of hafnium and zirconium, production, and uses of these alloys and metals in the nuclear power industry. (J.C.W.)

27762 REACTION OF HYDROGEN WITH PRASEODYMIUM AT VARIOUS TEMPERATURES. Gayer, K. H.; Grunwald, J. J. (Wayne State Univ., Detroit). J. Chem. Eng. Data; 15: 160-4 (1970).

The reaction of praseodymium with hydrogen was investigated in the temperature region 100 to 800°C. The predominant portion of the hydrogen is taken up at a constant rate. The final saturation with hydrogen is diffusion-controlled and obeys the parabolic laws. A reaction mechanism is proposed in terms of the various phases of reaction displayed by plots of average composition vs time. (auth)

27763 MAGNESIUM THERMAL METHOD OF OBTAINING Co-Mg AND Ni-Mg AND THEIR PROPERTIES. Perminov, V. P. Zh. Prikl. Khim.; 43: 62-5(Jan 1970). (In Russian).

The pycnometric density of Co-Mg containing 76.13 wt % Co was found to be 9.566, and Ni-Mg containing 58.71 wt % Ni was found to be 7.406. The microhardness of the $MgCo_2$ phase and the $MgNi_2$ phase was equal to 760 and 340 kg/mm², respectively. Aqueous solutions of KOH and H_2SO_4 and concentrated HCl did not affect Co-Mg very much, but reacted with Ni-Mg. Concentrated HCl reacted effectively with both alloys. (tr-auth)

27764 OBTAINING TUNGSTEN-RHENIUM PRECIPITATES FROM PARA-GAS PHASE. Tokaev, Yu. N.; Golovanov, Yu. N.; Krasovskii, A. I. Tsvetn. Metal.; No. 10, 61-3(Oct 1969). (In Russian).

Studies were made on the combined precipitation of rhenium and tungsten from a mixture of their hexafluorides with hydrogen. The microstructure of compact precipitates showed that the W-Re precipitates differed significantly from precipitates of tungsten. Isochronal annealing showed that recrystallization of the W-Re alloy took place at 1200, 1700, 2000, and 2200°C when the rhenium content was 0, 0.4 to 0.43, 1.0, and 3.0% respectively. Thus, the introduction of rhenium in tungsten by this method increased the temperature of the heat resistance. (R.V.J.)

27765 MODIFICATION OF CAST ZIRCONIUM BY ADDITIONS OF Ti, V, Cr, Mn, Fe, Co, AND Ni. Kashchuk, V. A.; Filippov, V. F. Tsvetn. Metal.; No. 10, 76-7(Oct 1969). (In Russian).

Small additions of Group IV metals to zirconium improved the electric conductivity and microhardness. The maximum increase of microhardness and the electric resistance of zirconium was observed with additions of manganese. With the additions of Fe, Co, and Ni, microhardness was increased less than additions of Cr and Mn, but greater than additions of Ti and V. The degree of increase of microhardness of zirconium was also affected by additions of Fe, Co, and Ni. (R.V.J.)

27766 AMMONIA DECOMPOSITION ON TUNGSTEN SURFACES. Dawson, P. T.; Peng, Y. K. (McMaster Univ., Hamilton, Ont.). J. Chem. Phys.; 52: 1014-15(15 Jan 1970).

Variations in results in studies on the decomposition of ammonia on tungsten surfaces using field electron emission microscopy (FEM), low energy electron diffraction (LEED), and flash desorption are discussed. In the FEM the field emission patterns, measured work functions ϕ, and Fowler-Nordheim pre-exponentials at $T \sim 1100°K$ for NH_3 adsorption at 300°K were identical to those obtained by N_2 adsorption. However, the N_2 diffraction pattern obtained from NH_3 adsorption in the LEED study had to be called a "pseudo-N_2 pattern" to agree with the N_2/H_2 desorption stoichiometry. Elimination of this latter requirement would make this a "true N_2 pattern" in agreement with the FEM observations. Also, the general conclusions between the papers regarding the mechanism of NH_3 decomposition are not in agreement. It is believed that N_2 desorption is not the rate-limiting step in NH_3 decomposition on W, but involves the surface decomposition of a surface species containing N and H for the following reasons. It is not apparent how a zero-order reaction and a H_2 isotope effect can be explained simultaneously by assuming N_2 desorption to be rate limiting. For adsorption temperatures above 300°K simultaneous pressure bursts of N_2 and H_2 were observed at 950°K, which was in excellent agreement with the original FEM observations. (J.C.W.)

27767 RADIOMETRIC INVESTIGATION OF THE UNIFORM DENSITY OF CIRCULAR SPECIMENS MADE OF COPPER POWDER BY CYCLIC PRESSING. Dumitrescu, Th.; Storin, Adina. Metalurgia (Budapest); 21: 582-5(Nov 1969). (In Rumanian).

The cyclic pressing technique, based on the stepwise compression of metallic powder, is widely used for the fabrication of large copper pieces. Density variation of the product may be determined radiometrically by adsorption or backscattering of radiation. Such a study was carried out using a 100 mCi, ^{170}Tm radiation source for the γ-absorption method. The study revealed that the density of the pressed copper pieces varied by ±7%. The radiometric method was considered well suited to determine density changes under various pressure conditions. (JPRS)

27768 THERMODYNAMIC ANALYSIS OF THE DEOXIDATION OF LIQUID MOLYBDENUM. Kozina, L. N.; Revyakin, A. V.; Samarin, A. M. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR; 190: 909-11(1 Feb 1970). (In Russian).

Isobaric and isothermic potentials of the removal of oxygen from molybdenum during vacuum melting were used as basis for the thermodynamic calculations. Removal of the oxygen from these binary systems could take place as a result of a direct elimination of the oxygen from the solution or by the evaporation of the oxides. The evaporation rate is proportional to the partial pressure; therefore, determination of the equilibrium composition above the solution of oxygen in molybdenum should indicate the process involved in the removal. The calculations revealed that the deoxidation passes through the stage of the suboxides; carbon was found to be the strongest deoxidizing agent. As the carbon content of molybdenum is always higher than that of oxygen, the carbon contained in the metal controls the deoxidation rate. (TTT)

27769 PROPERTIES OF WELDED JOINTS OF ZIRCONIUM ALLOY WITH 2.5 PERCENT Nb WITH TITANIUM ALLOYS. Novosadov, V. S. Svar. Proizv.; No. 11, 22-4(1969). (In Russian).

Regardless of the means of welding by melting (argon-arc, electron beam) welded joints of zirconium (containing 2.5% Nb) with titanium alloys have satisfactory plastic properties and strength determined by the strength of the zirconium alloy. The impact toughness of the joints after electron beam welding was higher than after argon-arc welding. Heat treatment in a vacuum at 600°C for 36 hours increased the bending angles, and the impact toughness of the joints increased by more than 2 times. (JPRS)

27770 REACTION-KINETIC METHODS FOR COMPARISONS BETWEEN HEAT-TREATMENT CYCLES. Grounes, M. (Aktiebolaget Akers, Styckebruk, Sweden). Jernkontorets Ann.; 154: 65-9 (1970). (In Swedish).

A systematic survey is given of different equations published, based on reaction kinetics and aiming at describing the effect of temperature and time on the properties of a heat-treated metal. (auth) (Sweden)

27771 C CURVES DETERMINED BY ISOTHERMAL TREATMENTS IN THE AGE-HARDENING Cu-Cr, Cu-Be, AND Cu-Co_2Si ALLOYS. Toda, Tadatoshi (Hitachi Ltd., Japan). Trans. Jap. Inst. Metals; 11: 30-5(Jan 1970).

In an age-hardened copper base alloy subjected to the solution treatment at a slow cooling rate, a supersaturated solid solution could not be obtained at room temperature, and its age-hardenability deteriorated considerably. The critical cooling rate (CCR) in solution treatment was studied by the isothermal heat treatment methods. The C curves which showed the precipitation behaviors of the alloying element in solution treatment were obtained in the Cu-0.7% Cr alloy, the Cu-2.5% Be-0.3% Co, and Cu-4% Co_2Si alloys. The CCR was determined to be 20°C/sec at 925°C (the nose temperature of the C curve) for the Cu-Cr alloy, 60°C/sec at 500°C for the Cu-Be alloy, and 20°C/sec at 940°C for the Cu-Co_2Si alloy. In the preceding paper the CCR of each alloy was determined by the Jominy test, i.e., continuous cooling, whereas in this paper the CCR was determined by the isothermal method, i.e., discontinuous cooling. There was good agreement in CCR determined by both methods. (auth)

27772 CRITICAL COOLING RATES DETERMINED BY THE JOMINY TESTS IN THE AGE-HARDENING Cu-Cr, Cu-Be, AND Cu-Co_2Si ALLOYS. Toda, Tadatoshi (Hitachi Ltd., Japan). Trans. Jap. Inst. Metals; 11: 24-9(Jan 1970).

The Cu-0.7% Cr alloy, the Cu-2.5% Be-0.3% Co alloy, and the Cu-4% Co_2Si alloy were used with the object of studying the critical cooling rate (CCR) for the solution treatment of an age hardened copper-base alloy. The critical cooling rate was defined as the cooling rate necessary to obtain a supersaturated solid solution at room temperature. The critical cooling rate of each alloy was determined by Jominy end quenching methods using a specimen of 25 mm diameter and 100 mm length. The CCR obtained was 17°C/sec at 925°C for the Cu-Cr alloy, 60°C/sec at 500°C for the Cu-Be alloy, and 20°C/sec at 940°C for the Cu-Co_2Si alloy. (auth)

27773 STUDIES ON THE ELECTRODE MATERIALS FOR MHD POWER GENERATORS. Masai, Tadahisa; Ishibashi, Eiichi (Hitachi Ltd., Ibaraki, Japan). Collect. Lect. Pap., Jap. Soc. Mech. Eng.; No. 217, 77-80(Aug 1969). (In Japanese).

The electrode is one of the important problems for the practical use of MHD power generation, but to date, no electrode of sufficient endurance has been discovered. In this connection, experiments were performed with several electrode materials, by observing the behavior of the arc spot produced on the electrode surface when external voltage was applied to them. Three pairs of electrodes, one main and the other two auxiliaries, were inserted, the two rods in each pair opposing to each other. High-temperature gas was passed through between the electrode pair. The materials for the main electrode were: ^{25}Cr-^{2}Al, ^{30}Cr-^{45}Ni-^{2}Al, and ^{40}Ag-^{60}W. An arc spot formed on the up-stream end of the cathode, moved with gas flow, and then disappeared at the down-stream end repeatedly. A high-intensity arc spot like that on the cathode did not appear on the anode. The anode consumption was caused mainly by oxidation and corrosion. The consumption of the cathode was due to localized melting or evaporation by the arc spot. (NSA of Japan)

27774 FRICTION AS A CHARACTERISTIC OF METAL POWDERS. Hausner, H. H. pp 1.3.1-14 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band I. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.1).

A metal powder is characterized by a great variety of factors. Between many of these factors or characteristics a rather complex correlation exists which usually makes it difficult to predict the behavior of a powder during processing. It was established that many of these characteristics determined the friction conditions in a mass of powder, and that friction itself could be used as a valuable characteristic of the powder. The effects of the material, the size, shape, and surface conditions of the particles, on the friction behavior of the powder are discussed. (auth)

27775 DISPERSIONAL STABILIZATION OF MAGNESIUM SYSTEMS. Cech, B.; Splichal, K. (Nuclear Research Inst., Rez, Czech.). pp 2.4.1-17 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.1a).

Structural and granulometric changes in oxide and fluoride admixtures were studied after extrusion sintering of magnesium and their effect on mechanical and corrosion properties was found. The resistance of the structure at prolonged annealing to secondary recrystallization and migration of the initial grain boundaries was studied in the presence of dispersed MgO, MgF_2, Fe, Zr, Nb, and Be. Dispersed MgO and MgF_2 in amounts below 4% with the particle size below 1 μm did not permanently inhibit secondary recrystallization of magnesium matrix at temperatures exceeding 500°C. The stability against recrystallization was increased by the addition of dispersed metals such as Fe, Nb, Zr, or Be when simultaneously some of them reduced the formation of cavities and pores arising from gases evolved during annealing. (auth)

27776 SOME ASPECTS OF BERYLLIUM POWDER METALLURGY. Logerot, J. M.; Syre, R. pp 2.6.1-31 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In French).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.1a).

The development of Be has received an impetus from aerospace technology, where the mechanical and physical properties (of Be) are optimally exploited. For the most ambitious applications, such as high-precision mechanical pressings, the standard commercial quality is not always suitable. Because of this, some research was performed, in liason with the users, in order to improve the mechanical characteristics and technological qualities of the material by using purer powders; by improving powder fineness without lowering the purity; by the addition of certain metallic elements or insoluble phases; and finally by the application of various heat-treatments adapted to the field of use and to the metallurgical history of the material. Thus, one can obtain products sintered to the highest elastic limit, plates with improved texture, strong drawn bars having a deformation-capacity of 30 to 50%, and structures resistant to creep at high temp., etc. (auth)

27777 SOME EFFECTS OF POWDER PARTICLE SIZE ON THE PHYSICAL BEHAVIOR OF PRESS FORGED BERYLLIUM. Greenspan, J. pp 2.7.1-19 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.1a).

Powder metallurgy Be generally contained an oxide dispersoid, attributable to particle surface scale, and thus the material actually was a system subject to particle strengthening. The present report shows a dependence of strength on raw powder particle size, and further on thermal history. (auth)

27778 PREPARATION AND PROPERTIES OF W–Cu–Ag–Ni ALLOYS. Barta, J.; Kelner, N. (Ministry of Defence, Tel Aviv, Israel). pp 3,3.1-15 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.1a).

Heavy metals should have favorable preparation characteristics, high density, and good machinability and electrical properties. Six W–Ag–Cu–Ni alloys were investigated: 85%, 90%, 95% W with either matrix I (70% Ag, 25% Cu, 5% Ni) or matrix II (70% Cu, 25% Ag, 5% Ni). Specimens prepared by isostatic pressing (18,000 psi) and sintered in hydrogen between 1000 and 1300°C showed that the 90% W-matrix I and 95% W-matrix II alloys reached densities of 16.5 to 17.5 g/cm (above 95% of T.D.) at 1100°C and 17.5 to 18.2 g/cm at 1300°C. W-matrix II alloys gave lower densities (13 to 15 g/cm, 75 to 90% of T.D.). There was no evidence of solubility between W and the matrices. Specimens prepared by blending suitably sized tungsten powders gave an increase of about 50% in green density but the sintered densities were only 80 to 90% of T.D. Machinability, electrical conductivity, and electrical contact resistance were determined for some of these alloys. (auth)

27779 INFLUENCE OF IMPURITIES ON THE DEFORMATION OF HIGH-MELTING METALS. Pink, E.; Sedlatschek, K. pp 3,6.1-15 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.1a).

The difficulties which occurred in the processing and practical application of the refractory metals molybdenum, tungsten, and tantalum emphasized the importance of the impurity elements oxygen, carbon, and nitrogen. Tensile tests, carried out at various temperatures, provided information on the behavior of these metals. Three temperature ranges with different deformation behavior can be distinguished: range I–of low temperature brittleness, range II–of ductile behavior at intermediate temperatures and, range III–of ductile behavior at high temperatures with incipient grain boundary embrittlement. The contaminants affected the behavior of the metals differently in each of these ranges. Due to the low solubilities, they were present as solid solutions as well as in the form of chemical compounds in the grain boundaries. Impurity atoms dissolved as interstitials affected deformation behavior in range II, grain boundary impurities in range I and III. The fact that the grain boundary contaminants were mainly responsible for the loss in ductility should be taken into account in designing the tests. (auth)

27780 EFFECT OF DISPERSOID PROPERTIES ON THE DISPERSION STRENGTHENING OF CARBONYL IRON. Singh, B. N.; Cotterill, P.; Waldron, M. B. pp 6.21.1-14 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.2a).

The dispersion strengthening of carbonyl iron, by alumina and zirconia, was found to be sensitive to particle morphology. This was studied, by optical and electron microscopy, in samples representing each stage of various production sequences. In the case of alloys which were sintered at 1350°C, and then forged and cold-rolled, alumina had a greater room-temperature strengthening effect than did zirconia; whereas, for alloys sintered at the same temperature but tested in the extruded condition there was no such difference in strengthening effect. Furthermore, sintering at 1200°C followed by forging and cold-rolling produced a similar degree of dispersion strengthening for each of the two dispersoids. These effects are interpreted in terms of the variation of particle morphology with production history. Tensile properties were also determined at temperatures in the range 20 to 600°C for alloys which were sintered at 1350°C and extruded. The dispersion strengthening effect decreased with increasing temperature in a manner which was consistent with the experimentally determined recrystallization temperature of these alloys. (auth)

27781 MAGNETIC AND MECHANICAL PROPERTIES OF DISPERSION-STRENGTHENED IRON. Bufferd, A. S.; Towner, R. J. pp 6.23.1-23 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.2a).

The coercive force of dispersion-strengthened iron extrusions increased with increased volume percent oxide at room temperature and 1200°F. The saturation magnetization values of iron at room and elevated temperatures were decreased in proportion to the volume fraction of nonmagnetic phase present. The combination of magnetic and mechanical properties of dispersion-strengthened iron is promising for the further development of magnetically soft materials for service in the 1200°F temperature region. (auth)

27782 COMPOSITION OF α SOLID SOLUTION IN Ti–Al–Mo AND Ti–Al–V. Fedotov, S. G.; Ronami, G. N.; Konstantinov, K. M.; Kuznetsova, S. M.; Sinodova, E. P.; Starokozhev, B. S. Izv. Akad. Nauk SSSR, Metal.; No. 6, 167-71(Nov-Dec 1969). (In Russian).

The chemical composition of $\alpha + \beta$ solid solution in two-phase alloys of Ti–Al–Mo and Ti–Al–V was studied using x-ray spectral analyses and microanalyses. The results of molybdenum or vanadium additions on stability are tabulated. Aluminum in the α solid solution of the ternary alloys was in the isomorphous β phase according to the crystalline structure. (tr-auth)

27783 PLASTICITY OF INDIUM. Gladkikh, A. N.; Skudnov, V. A.; Sokolov, L. D. Izv. Akad. Nauk SSSR, Metal.; No. 6, 138-40(Nov-Dec 1969). (In Russian).

The plastic properties of polycrystalline indium (99.999% pure) were studied from 70 to –196°C. The temperature relationship between stability, ductility, and other physical properties was determined. (tr-auth)

27784 EFFECT OF TEMPERATURE ON PHYSICAL PROPERTIES OF TWO- AND THREE-PHASE TITANIUM–TUNGSTEN SOLID SOLUTIONS. Tumanov, V. I.; Mozzhukhin, E. I.; Elmanova, S. M. (All Union Research Inst. of Solid Alloys, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 15-19(Jan 1970). (In Russian).

The relationship of temperature to thermal expansion, electric resistance, and ductility of two- and three-phase Ti–W solid solutions was studied at 20 to 800°C. The effects of additions of cobalt on the physical properties were studied. The relation of coercive force and volumetric content with the inclusion of carbide impurities showed tendencies on the concentration of binding phases of 6 and 11 vol % in the alloys. Alloys with more than 6 vol % Co in the two-phase alloys and more than 12 vol % Co in the three-phase alloys had isolated carbide grains in the cobalt matrix. (tr-auth)

27785 SOLUBILITY OF NITROGEN IN NIOBIUM–MOLYBDENUM SOLID SOLUTIONS. Hoerz, G.; Steinheil, E. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals; 21: 84-8(1970).

The solubility of nitrogen in Mo–Nb alloys with 0 to 100 at.% Mo was extensively studied. The relations between nitrogen partial pressure, temperature, and nitrogen concentration, for the range of the ternary Mo–N–Nb solid solution up to the solubility limit of nitrogen were determined. Thermodynamic data were calculated. (G.M.C.)

27786 STAINLESS STEEL REACTOR PRESSURE VESSELS. Karnoski, P. J. Jr. (Brown and Root, Inc., Houston, Tex.); Fretague, W. J.; Potapovs, Uldis; Steele, L. E. Nucl. Eng. Design; 11: 347-67(Apr 1970).

The properties of stainless steels preferred for nuclear reactor pressure vessel construction, the austenitic-chromium-nickel types, are reviewed along with other bases for this nuclear application. The engineering criteria which establish the limits for design and operation, the various aspects of vessel fabrication and the implications of the environmental effects, radiation and corrosion, are described. (auth)

27787 EMBRITTLEMENT OF U BY H_2O AND HYDROGEN. Hughes, A. N.; Orman, S.; Picton, G. (Atomic Weapons Establishment, Aldermaston, Eng.). Corros. Sci.; 10: 239-44(Apr 1970).

The problems of attributing mechanical failure of a metal to either stress corrosion cracking or hydrogen embrittlement with limited fractrographic or tensile data are discussed with respect to U. Detailed investigations with this metal have shown that both forms of embrittlement occur, and although similar in effect, the mechanisms are distinct. (auth) (UK)

27788 STUDY ON DIFFUSION OF CARBON IN TANTALUM AND ZIRCONIUM BY X.M.A. Suzuki, Hiroshige; Kimura, Shushichi; Hase, Teizo; Tsuchie, Yasuo (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 90, 105-15(Mar 1969).

Tantalum (grain size ~500 μ) and zirconium (grain size 15 ~ 45 μ) contacting with carbon were diffusion annealed over the temperature range 1600 to 1900°C and 1100 to 1700°C, respectively. After carbon concentration-distribution curve was measured, the volume diffusion coefficients of carbon in tantalum and zirconium

obtained from electron-probe microanalyzer (X.M.A.) were as follows: Ta: $D_v = 8.54 \times 10^{-4}$ exp (–52,500/RT) cm^2 sec; Zr: $D_v = 1.40 \times 10^{-6}$ exp (–30,000/RT) cm^2/sec. Grain size of zirconium was about the same with an expected region characteristic x-ray excited by electron beam, so that both volume diffusion and grain-boundary diffusion revealed on carbon concentration curve. Then, separating both diffusion effects graphically, and applying Fisher's equation, the grain-boundary diffusion coefficient D_{gb} was calculated as Zr: $D_{gb} = 2.35 \times 10^{-1}$ exp (–24,100/RT) cm^2/sec. Volume diffusion coefficient of carbon in tantalum was two orders of magnitude lower than diffusion coefficients by R. W. Powers et al. and P. Son et al. This difference would be reasoned by considering that the latter included possibly grain-boundary effect. The ratio of grain-boundary diffusion coefficient D_{gb} to volume diffusion coefficient D_v of carbon in zirconium was nearly 10^5 over a wide range of temperature. This implies that grain-boundary diffusion coefficient is considerably larger than volume diffusion coefficient. (auth)

Structure and Phase Studies

Refer also to abstracts 27882, 28184, and 28203.

27789 (AD–700023) EXAMINATION OF ETCHED NIOBIUM AND NIOBIUM ALLOYS IN POLARIZED LIGHT. Trenouth, J. M.; Grzedzielski, M. S. (National Aeronautical Establishment, Ottawa (Ontario)). Jun 1969. 19p. (NAE-MS-124; NRC-11030). CFSTI.

Although optically isotropic, niobium and the niobium alloys B66 and FS85 could be made to respond to polarized light by a suitable etching treatment. The etching technique and possible uses of the ensuing activity in polarized light are described. New evidence that the activity of such isotropic metals due to the surface topography is presented. The surface structure and its crystallographic relation are discussed with particular reference to similar observations on fcc metals. (auth) (USGRDR)

27790 STACKING DISORDER IN MARTENSITES OF COBALT AND ITS ALLOYS. Kajiwara, Setsuo (National Research Inst. for Metals, Tokyo). Jap. J. Appl. Phys.; 9: 385-90(Apr 1970).

Stacking disorder in the hcp martensites of the pure Co, Co–10.2 at. % Be, and Co–19.5 at. % Ni alloys has been studied by electron diffraction, utilizing the selected-area diffraction technique of an electron microscope. The shifts of diffraction spots along the [00.1] direction due to stacking faults are observed with these martensites. The shifts are analyzed by the Kakinoki theory with Reichweite s = 2, and the corresponding stacking fault probabilities are found to be $\alpha = 0.03 \sim 0.3$. It is considered that these stacking faults are introduced due to the constraints imposed by the surrounding matrix crystal. (auth)

27791 STRUCTURE OF CERIUM ABOVE 50 KBAR. McWhan, D. B. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 1: 2826(15 Mar 1970).

In situ x-ray-diffraction experiments suggest that above 50 kbar Ce is similar to Ti and Zr, which are hexagonal close packed. (auth)

27792 AXIAL RATIOS AND SOLUBILITY LIMITS OF H.C.P. eta AND epsilon PHASES IN THE SYSTEMS Cd–Mn AND Zn–Mn. Farrar, R. A. (Univ. of Southampton, Eng.); King, H. W. Metallography; 3: 61-70(Mar 1970).

Solubility limits and lattice parameters were determined across the terminal solid solutions in the systems Cd–Mn and Zn–Mn and across the ϵ phase in Zn–Mn. Increases in axial ratio across the η solid solutions were attributed to an increase in the overlap across the {00.2} faces of the Jones zone, indicating that manganese acted as divalent in these solutions. A change in the slope of the axial ratio-versus-composition plot at 78 at.% Zn was attributed to the onset of the {00.2} zone overlap, as found in the ϵ phase manganese acted as univalent. These changes in the electronic configuration of manganese are related to its atomic volume in the various environments. (auth)

27793 SINTERING PHENOMENA IN THE Nb–Sn SYSTEM WITH REGARD TO THE Nb_3Sn PHASE. Rutkowski, W.; Horubala, Z. pp 3.1.1-18 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.1a).

The formation of the Nb_3Sn phase during sintering of Nb–Sn powder mixtures was examined. Nb–Sn powder mixtures containing 10 to 50 wt % Sn were compacted under pressures varying from 0.5 to 4×10^8 N/m^2. Degassing was carried out in a vacuum at 470 to 870°K, and sintering at 1270, 1570 to 1770, and 2070°K in a vacuum 10^{-4} to 10^{-5} torr. Density, hardness, and shrinkage tests as well as metallographic and radiographic analyses of the compacts were made. The optimum conditions for practically 100% formation of the Nb_3Sn phase were obtained with 30% Sn content, 3×10^8 N/m^2 pressure, 1270°K sintering temperature, and slow cooling in vacuum. (auth)

27794 PHASE DIAGRAM OF Ca–Eu. Stroganova, V. F.; Terekhova, V. F.; Savitskii, E. M. Izv. Akad. Nauk SSSR, Metal.; No. 6, 146-9(Nov-Dec 1969). (In Russian).

The phase diagram of the Ca–Eu system was constructed from physicochemical analysis methods. Microhardness, density, and phase regions were studied. (tr-auth)

27795 Hf–Ni–Al SYSTEM. Markiv, V. Ya.; Burnashova, V. V. Izv. Akad. Nauk SSSR, Metal.; No. 6, 181-4(Nov-Dec 1969). (In Russian).

An investigation of the Hf–Ni–Al system was made using x-ray and microstructural techniques. New phases found were λ_2(~$HfNi_{1.5}Al_{0.1}$), L(~$Hf_4Ni_{16}Al_5$) and λ_1($HfNi_{0.6}Al_{1.4}$). The isothermal section was constructed at 800°C. (tr-auth)

27796 STRUCTURE AND PROPERTIES OF Au–Pd–W. Pravoverov, N. L.; Begetova, I. S. Izv. Akad. Nauk SSSR, Metal.; No. 6, 177-80(Nov-Dec 1969). (In Russian).

The phase diagram of Au–Pd–W was studied. The region of homogeneous solid solutions at room temperature was found. Certain physicomechanical properties were studied. Additions of tungsten to Au–Pd improved stability properties of the alloy. (tr-auth)

27797 STRUCTURE AND PROPERTIES IN Al–Y RICH IN ALUMINUM. Drits, M. E.; Kadaner, E. S.; Nguyen Tin Shoa. Izv. Akad. Nauk SSSR, Metal.; No. 6, 150-3(Nov-Dec 1969). (In Russian).

The phase diagram of the Al–Y system rich in aluminum was constructed. Microstructure and mechanical properties were studied at room temperature to 200°C. (tr-auth)

27798 SURFACE SOLIDUS OF Ti–Ta–Nb WITH METHOD OF MATHEMATICAL STATISTICS. Gavze, A. L.; Budberg, P. B.; Minaeva, S. A. Izv. Akad. Nauk SSSR, Metal.; No. 6, 159-62 (Nov-Dec 1969). (In Russian).

A solidus diagram of the system Ti–Ta–Nb was constructed. A statistical evaluation was carried out, and its adequacy established. (tr-auth)

27799 PHASE EQUILIBRIUM OF PART OF SYSTEM Ti–Al–Mo. Nartova, T. T.; Shirokova, N. I. Izv. Akad. Nauk SSSR, Metal.; No. 6, 163-6(Nov-Dec 1969). (In Russian).

Polythermal and isothermal cross sections of Al–Mo–Ti were constructed in the equilibrium state at 500 to 1000°C. The presence of 7 phase regions in the isothermal cross section of the alloy was observed. It was found that the microstructure of the alloy after annealing at 1200°C showed spinel structures in the β phase. (R.V.J.)

27800 THE OBSERVATION OF DEFORMATION TWINS IN QUENCHED AND COLD-ROLLED Ni_3Mo. Liu, Y. H. (Republic Steel Corp., Independence, Ohio). Mater. Res. Bull.; 5: 315-18 (May 1970).

The development of deformation substructure induced by cold rolling of a disordered Ni_3Mo alloy was investigated using transmission electron microscopy. Deformation twins whose spacings varied from 100 to 460 Å were observed in the quenched Ni_3Mo sample subjected to 48% cold reduction. The presence of twin boundaries might act as preferential sites for nucleation of the ordered Ni_3Mo phase. It is suggested that the effect of prior deformation on the formation of the ordered Ni_3Mo phase during subsequent aging of a Ni–Mo alloy near the Ni_3Mo composition can be reinterpreted in this manner. (auth)

Radiation Effects

Refer also to abstracts 26996, 27102, 27286, 27439, and 27441.

27801 (NYO–3504-46) DEFECTS IN METAL CRYSTALS. Annual Progress Report, May 1, 1969–April 30, 1970. Balluffi, R. W.; Seidman, D. N. (Cornell Univ., Ithaca, N. Y.). 13 Mar 1970. Contract AT(30-1)-3504. 30p. Dep. CFSTI.

The objective of the present research effort was a broad investigation of the basic properties of defects in metal crystals. Attention was focused on point defects (vacancies, interstitials, and solute atoms), line defects (dislocations), and planar defects (dislocation arrays, grain boundaries and surfaces). Progress was made in the following areas: defects observed by electron microscopy in silver bombarded with silver ions; annealing ki-

netics of vacancy defects in quenched gold at elevated temperatures; rapid self-diffusion along dislocations in aluminum; electron microscopy study of low and high angle grain boundaries in gold; field ion microscopy of gold; an in situ field ion microscopy study of Stage I recovery of tungsten irradiated with 20 keV tungsten ions; study of vacancy defects in quenched platinum via field ion microscopy and electrical resistivity measurements; study of displacement spikes in irradiated tungsten; an in situ field ion microscope study of Stage I of platinum irradiated with platinum ions; and construction of field ion microscope equipment. (auth)

27802 (RD/B/N-1584) SWELLING DURING HIGH TEMPERATURE NEUTRON IRRADIATION: THE INFLUENCE OF SURFACE ENERGY AND STACKING FAULT ENERGY ON VOID NUCLEATION. Buswell, J. T. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb 1970. 19p. Dep. CFSTI (U. S. Sales Only).

An assessment was made of the influence of the relative energies of vacancy dislocation loops and voids on the susceptibility of a material to swelling during high temperature neutron irradiation. There is experimental evidence that in pure metals in which loops are the lower energy defects, higher fluences are required to produce voids. In stainless steel (AISI 304), and most other alloys, the comparative resistance to swelling cannot be explained by an initial absence of void nuclei. Voids are the lower energy defects and potential nuclei are present throughout irradiation. Alloying influences void formation in a way other than through its effect on the energies of loops and voids. It is not feasible to influence the relative energies of dislocation loops and voids by changes in alloy composition. The necessary changes in composition are large and require the removal of the solute. (auth) (UK)

27803 EFFECTS OF γ-IRRADIATION ON DEGRADATION OF AUSTENITE IN STEEL. Konozenko, I. D.; Krulikovskaya, I. P. Izv. Akad. Nauk SSSR, Metal.; No. 6, 134-7(Nov-Dec 1969). (In Russian).

The process of degradation of austenite during annealing was studied at 700°C. Monocrystalline steel irradiated by gamma radiation was compared with nonirradiated samples. Analysis showed that previous irradiation accelerated the decomposition of the austenite during annealing. (tr-auth)

27804 VISCOELASTIC CREEP OF TUBES SUBJECTED TO IRRADIATION GROWTH. Goodall, I. W. (Berkeley Nuclear Labs., Eng.). J. Brit. Nucl. Energy Soc.; 9: 120-4(Apr 1970).

An outline is given of calculations that were undertaken to assess the stresses and deflexions likely to occur in tubes subjected to irradiation growth and creep. The tubes are prevented from rotating at their ends but are free to expand axially, and are treated as beams. (auth) (UK)

27805 CORROSION OF MATERIALS USED IN NUCLEAR POWER STATIONS. Bradhurst, D. H. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Proc. Roy. Aust. Chem. Inst.; 37: 39-43(Feb 1970).

Stainless steels and other relatively highly absorbing materials can be used in fast reactors using enriched fuel, but metals of low cross-section for neutron capture are necessary in thermal reactors. Zirconium in particular is considered, and the effects of neutron radiation and oxidation on zirconium and its alloys in water-cooled and moderated reactors are summarized with mechanistic considerations. The development of the Zircaloys is reviewed. (Australia)

Ceramics and Cermets

Corrosion and Erosion

Refer also to abstract 27035.

27806 FACTORS AFFECTING THE PRODUCT RATIO OF THE CARBON-OXYGEN REACTION. II. REACTION TEMPERATURE. Phillips, Roger; Vastola, F. J.; Walker, P. L. Jr. (Pennsylvania State Univ., University Park). Carbon; 8: 205-10(Mar 1970).

The reaction of Graphon with O_2 was studied at temperatures between 525 and 675°C, using initial O_2 pressures between 10 and 200 mtorr. and a sample varying in burn-off between zero and 28%. Reaction temperatures were low enough for secondary reactions to be neglected. A mass spectrometer was used to monitor the partial pressures of O_2, CO and CO_2. The amount of stable oxygen complex on the surface was determined by decomposing it at elevated temperatures. Using an interpolation technique, the variation of product ratio with temperature at various constant carbon burn-offs and surface oxide formations could be determined. The variation of product ratio, CO/CO_2, with temperature is given by $A \exp(-E/RT)$ where $E = 6 \cdot 4$ kcal/mole and is independent both of carbon burn-off and surface-oxide formation. The pre-exponential factor A increased with increasing carbon burn-off and decreasing surface oxide coverage. (auth) (UK)

Preparation and Fabrication

Refer also to abstracts 27031, 27290, 27744, 27745, 27746, and 29041.

27807 (EUR-4413) CERAMOGRAPHY OF AMERICIUM OXIDES. Sari, C.; Tebaldi, V.; Pietra, I. Della (European Atomic Energy Community, Karlsruhe (West Germany). Transuranium Inst.). 18 Sep 1969. 16p. Dep. CFSTI (U. S. Sales Only). EUR FF 4.45.

The procedure, the apparatus, and the etching conditions used for the ceramographic analysis of americium oxides are reported. The results of microhardness measurements are given. A tentative americium–oxygen diagram was drawn. (auth)

27808 PROCESS OF PREPARING NUCLEAR FUEL. Triggiani, Leonard V.; Haberman, Norton; Sanchez, Moises G. (to W. R. Grace and Co.). U. S. Patent 3,501,411. 17 Mar 1970. Filed 21 Jun 1967.

A process for the preparation of a composite nuclear fuel of thoria, urania and mixtures thereof which contain small but significant amounts of a burnable poison is described. The purpose of the poison is to overcome the changes that occur in the distribution of neutron flux in the fuel and which result in the generation of heat to an undesirable degree in the element. Samarium, gadolinium, boron, and hafnium may be used as poisons. The burnable poison is incorporated into the fuel by an impregnation technique. (R.C.K.)

27809 GROWTH OF V_3O_5 SINGLE CRYSTALS. Nagasawa, Koichi; Bando, Yoshichika; Takada, Toshio (Kyoto Univ.). Jap. J. Appl. Phys.; 9: 407(Apr 1970).

The preparation of V_3O_5 monocrystals by a chemical transport method, using $TeCl_4$ as transport agent, is reported. Magnetic susceptibility measurements at 77 to 300°K show a jump at 140°K. (D.L.C.)

27810 SNAM PROCESS FOR THE PREPARATION OF CERAMIC NUCLEAR FUEL MICROSPHERES: CONTINUOUS PRODUCTION TECHNIQUE. Facchini, A. G. (AGIP Nuclear S.p.A., Milan). Energ. Nucl. (Milan); 17: 225-33(Apr 1970).

The production of ceramic nuclear fuel microspheres by the gel supported precipitation method, known as the SNAM process, is described in this paper. The complete flow-sheet of the process included two main sections: the microsphere forming wet section, including drop forming, aging, washing and drying; and the heat treatment dry section, including calcination and firing. All the operations were automatically performed following a continuous production technique, that was successfully established by direct and glove-box operation of different pilot plants. The main features which make the gel supported precipitation process particularly attractive are: the simple way of preparing the feeding solution, which must be neither reduced nor denitrated; the wide diameter (150 + 1100 μM) and density (70 + 99% TD) ranges in which the microspheres can be produced with a low dispersion; the economic competitivity of the process in comparison with the other ones used at present. (auth)

27811 SNAM PROCESS FOR THE PREPARATION OF CERAMIC NUCLEAR FUEL MICROSPHERES: LABORATORY STUDIES. Brambilla, G.; Gerontopulos, P.; Neri, D. (AGIP Nucleare S.p.A., Milan). Energ. Nucl. (Milan); 17: 217-24 (Apr 1970).

The SNAM process, an original method for preparation of nuclear ceramic fuel microspheres, is described in this article. Details are given for each single process stage and the properties of the obtained products are illustrated. The advantages of the method over other competitive routes are discussed. The process was fully demonstrated on a several kilogram scale basis for urania, thoria, plutonia, and mixed oxide particles. (auth)

27812 THE PREPARATION OF SPHERICAL PARTICLES OF ACTINIDE HYDROXIDE GEL. (to Reactor Centrum Nederland (Stichting)). British Patent 1,191,047. 6 May 1970. Priority date 29 Sep 1967, Netherlands.

A method is described for the preparation of spherical particles of actinide hydroxide gel, consisting of mixing an actinide hydroxide sol with an aqueous solution of one or more of an ammonia-producing compound, which decompose in water to give off ammonia with a specific gravity of 1.7 to 2.0. The mixture is placed below the surface of a liquid gelling agent such as tetra-

chloroethane or tetrachloroethylene. The liquid gelling agent is non-miscible with water and has a specific gravity between 1.4 and 1.6. The ammonia-producing compound is a solution of hexamethylenetetramine and urea. Three examples are given of the gelling of a mixed thorium–uranium hydroxide sol; the gelling of a tetravalent uranium-hydroxide sol; and the gelling of a thorium-uranium hydroxide sol with carbon. (J.C.W.)

27813 FABRICATION OF DISPERSION-TYPE REACTOR FUEL CONSISTING OF UC AND SiC. Suzuki, Hiroshige; Matsunaga, Ichiro; Kimura, Shiushichi (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 90, 21-6(Mar 1969).

Dense silicon carbide was fabricated by reaction sintering, and its formation mechanism is briefly discussed. Dense reactor fuel UC dispersed in a SiC matrix was satisfactorily fabricated. Irradiation tests of these specimens are now being carried out at JMTR. (NSA of Japan)

27814 CONCERNING THE INFLUENCE OF THE O/U RATIO ON THE SINTERING OF URANIUM DIOXIDE. Bacmann, J. J. (Centre d'Etudes Nucleaires, Grenoble, France); Cizeron, G. J. Nucl. Mater.; 34: 337-9(Mar 1970). (In French).

The sintering of uranium dioxide was studied experimentally. The process depended strongly on the rate of temperature increase. Above 1000°C/min deformation, rupture, and distortions occurred quite frequently after cooling. The sintering process of uranium dioxide was explained as an intergranular diffusion of uranium rather than a volume diffusion. In favor of the intergranular concept were crystallographic measurements, dynamics of the sintering process, diffusion studies by tracer methods, and the diffusion coefficient. (H.B.G.)

27815 PRODUCTION AND PROPERTIES OF CERMETS WITH IDEALIZED STRUCTURE BY ISOSTATIC HOT PRESSING OF COATED PARTICLES. Bumm, H.; Thuemmler, F.; Weimar, P. pp 4.12.1-23 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.1a).

The process of isostatic hot compacting is not yet very widely used. It is described in the production of cermets in the uranium dioxide-molybdenum system. Coated particles were used as starting material. Impact and bend strength were determined on polished test pieces at room temperature with relation to porosity and metal content. Electrical and thermal conductivity were measured as a function of the molybdenum content. Within certain composition ranges the values obtained for the properties were superior to those for cermets made from mixed powders. Using a correction factor for porosity and a statistical approach comparative values are shown for the higher thermal conductivity of isostatically hot compacted coated powders as against powder mixtures. (auth)

27816 FABRICATION OF PENCIL-TYPE NUCLEAR FUEL ELEMENTS BY VIBROCOMPACTION OF CERAMIC POWDERS OF ONE PARTICLE SIZE. van Asbroeck, Ph. (CEEN, Mol, Belg.); Wieczorkowski, M. pp 4.13.1-22 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In French).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.1a).

In the vibro-compacting method of nuclear fuel fabrication, the fuel can was filled with loose powder and then compacted by vibration. In order to reduce the cost of the vibro-compacting, it was suggested that powders of one particle size only be used and that they be in the form of small cylindrical sintered pellets. The properties of the materials as well as the processes of filling and vibrating are described. It is shown that cylindrical pellets of the right size are easily compacted by vibration, resulting in a rearrangement and breakdown of particles leading to a density of 85% T.D. (auth)

27817 2. EUROPAEISCHES SYMPOSIUM UEBER PULVERMETALLURGIE, IN STUTTGART, VOM 8. BIS 10. MAI 1968. BAND II. (Second European Symposium on Powder Metallurgy, Stuttgart, 8–10 May 1968. Volume II). Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). 325p. (In several languages). (CONF-680504-(Vol.2)).

A total of 22 papers was presented at the conference and included in Volume II. A separate abstract was prepared for each of 5 papers. The remaining 17 papers were not within the scope of NSA. (G.M.C.)

For abstracts of individual papers see: 27746, 27818, 27819, 27843, and 27844.

27818 SOLID PROPERTIES OF COMPOSITE POWDERS FROM FLUID BED DECOMPOSITION. Bovarnick, B.; Flood, H. W. pp 6.2.1-25 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band II. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2).

Experience with the fluid bed for direct reduction of iron ore led to the hypothesis that the fluid bed offered opportunity for preparation of composite powders by decomposition of solutions of metallic salts. This concept was investigated for a number of systems including: dispersion strengthened alloys of iron with Al_2O_3, nickel with ThO_2, and copper with Al_2O_3; the magnetic alloy of nickel–iron–molybdenum; and ceramic ferrites of several types, especially a nickel–zinc base composition. The process required the formation of a stable solution of the elements of interest. The solution was decomposed to composite oxide particles in a heated fluid bed reactor. Depending upon the system, decomposition temperatures from 400 to 1100°C were employed. As required, the composite oxide powder was partially or fully reduced by hydrogen in subsequent steps. The powders were then consolidated to appropriate density by standard compacting and sintering of ceramic and metal powder technology. The structural alloys exhibited strength considerably greater than obtained from powders of similar compositions made by other process treatments. Both metallic and ceramic magnetic materials exhibited unusual properties for these classes of material. The fluid bed is also being studied for a number of other interesting materials. (auth)

27819 PRODUCTION AND PROPERTIES OF POROUS MATERIALS FROM HIGH-MELTING COMPOUNDS. Slepzov, W. M.; Witryanyuk, W. K.; Prschedromirskaya, E. M. pp 6.10.1-22 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band II. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2).

Investigations were carried out on the preparation of porous specimens of refractory compounds, by sintering powders either under static pressure in closed dies, or under vibration induced compression, or during the reduction of metal oxides for carbide formation. Optimum conditions were established for obtaining specimens with desired porosities. A favorable effect of vibration on the uniform distribution of porosity was observed. The sintering of porous specimens of refractory carbides with activating additions was investigated. From calculations of the activation energy of the process it was established that the additives lowered the sintering temperature. Strength characteristics of porous materials were studied. The number of open and closed pores and their distribution according to size were determined. (auth)

27820 PREPARATION AND SINTERING BEHAVIOUR OF URANIUM MONONITRIDE MADE BY THE CARBOTHERMIC REDUCTION OF URANIUM OXIDES IN NITROGEN. McLaren, J. R.; Dicker, R. I.; Harrison, J. D. L.; Russel, L. E. pp 8.4.1-27 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2a).

Uranium mononitride was prepared by reacting fragments of compacted mixtures of uranium oxide and graphite at high temperatures in flowing nitrogen and cooling the products in argon. The range of conditions studied included reaction temperatures of 1500 to 1700°C and times of 10 to 20 hours, and the reactant compositions investigated contained between 8.0 and 9.2 wt % C. The nitride-forming reactions proceeded predictably when due allowance was made for non-stoichiometry in the UO_2 and impurities in the carbon. Nitrides having the lowest carbon and oxygen products resulted from reactions carried out at the highest temperatures. The sintering behavior was studied, after ball milling and pressing the UN powders, by heating for 2 hours at 1700°C in flowing argon. To eliminate the effects of oxidation on the fine mononitride powders, all powder handling operations were performed in glove boxes with high purity argon atmospheres. The sintered products contained up to 10 wt % of UO_2 as judged by metallographic examination and the bulk density of the pellets appeared to decrease with increasing oxide content. Bulk densities of up to 95% theoretical were obtained after sintering at 1700°C for 2 hours. X-ray analyses of the sintered pellet materials showed a linear relationship between lattice parameter and carbon content but the cell sizes were all slightly smaller than would be expected from a Vegard's law relationship between UN and UC. This was not due to tungsten contamination picked up

from the tungsten carbide ball mill used to reduce the particle size of the powders prior to sintering. It is suggested that it arises because the true value for the lattice parameter of UN free from carbon contamination is 4.888 Å rather than 4.890 Å. (auth)

27821 REACTION ON THE SINTERING OF URANIUM MONOPHOSPHIDE. Moench, S.; Petzow, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 8,5,1-15 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2a).

High-vacuum sintering of UP at temperatures between 1500 and 2000°C was studied by x-ray analysis, quantitative metallography as well as by determining densities of green and sintered compacts. The following conclusions on the initial sintering mechanisms can be drawn: Considering the results below 1700°C, vaporization and recondensation could account for the transport mechanism. Between 1750 and 1950°C, material transport took place predominantly by volume diffusion and above 1950°C, liquid phase sintering occurred. Relations between UP stability and processes during high vacuum sintering are discussed. (auth)

27822 THE GROWTH OF RHENIUM(VI) OXIDE SINGLE CRYSTALS BY A VAPOR TRANSPORT MECHANISM. Quinn, Rod K.; Neiswander, Patricia G. (Sandia Labs., Albuquerque, N. Mex.). Mater. Res. Bull.; 5: 329-34(May(1970).

Large, well-formed, homogeneous crystals of rhenium trioxide were grown by a chemical-vapor transport reaction using iodine as the transporting agent. The conditions necessary for single crystal formation as well as measured structural and physical properties are described. (auth)

27823 ZIRCONIUM OXYNITRIDE FORMATION DURING ELECTROLYSIS OF STABILIZED ZIRCONIA. Wilcockson, A.; Casselton, R. E. W. (International Research and Development Co. Ltd., Fossway, Eng.) J. Amer. Ceram. Soc.; 53: 293(21 May 1970).

Metallic golden surface deposits of zirconium oxynitride formed when polycrystalline samples of 12 mole % $Y_2O_3-ZrO_2$, sandwiched between Pt electrodes, were electrolyzed in mixed N_2-Ar atmospheres. The composition $Zr(O_yN_{1-y})$ was a function of both the degree of blackening, or substoichiometry, and ambient nitrogen content. A large current density promoted increased substoichiometry which presumably proved more reactive for a given ambient nitrogen content. (G.M.C.)

Properties Evaluations

Refer also to abstracts 27727, 27737, 27771, and 27772.

27824 (AD-700766) THERMODYNAMIC PROPERTIES OF TERNARY REFRACTORY CARBIDES. IV. RELATIONS BETWEEN THERMODYNAMIC PROPERTIES, BONDING, AND COMPRESSIBILITY. Technical Report, July 1, 1967-June 30, 1969. Hoch, M.; Yamauchi, S. (Cincinnati Univ., Ohio). Dec 1969. Contract F33615-67-C-1565. 22p. (AFML-TR-69-209(Pt.4)). CFSTI.

The high temperature thermodynamic data obtained on ternary carbides having the sodium chloride type structure were correlated with the bonding and mechanical properties of these carbides. The metal-metal bonding on the metal sublattice in the carbide was the same as in the binary body-centered cubic metals. The variation of the carbon-carbon interaction energy and the metal-carbon interaction energy indicated that the metal-carbon bonds were localized bonds. From the variation of the difference in metal-carbon interaction energy with composition the compressibility of the carbides at elevated temperature can be calculated. The values are in excellent agreement with values derived from room temperature mechanical properties measurements. (auth) (USGRDR)

27825 (IJS-251) THE INFLUENCE OF COMPACTING PRESSURE AND OTHER FACTORS ON THE SINTERING OF UO_2. Kolar, D.; Zatler, B.; Brcic, B. S.; Marinkovic, V. (Institut Jozef Stefan, Ljubljana (Yugoslavia)). Nov 1969. 11p. (In Slovenian). (CONF-690636-2). Dep. CFSTI (U. S. Sales Only).

From Yugoslavia Conference on Industrial Chemistry, Belgrade, Yugoslavia.

The final density and microstructure of sintered UO_2 pellets depend on the powder characteristics and pressing and sintering conditions. The investigation demonstrated the negative influence of the parameters, which used separately, in some intervals promote the densification, i.e., increased specific surface area, and nonstoichiometry. Sintering results are supported by the microstructure investigations. (tr-auth)

27826 (NP-tr-1888) THE THERMAL DISSOCIATION OF HAFNIUM TETRAIODIDE. Gerlach, J.; Krumme, J.-P.; Pawlek, F. Translated for Univ. of Melbourne, from J. Less-Common Metals; 15: 303-10(1968). 10p. Dep. CFSTI (U. S. Sales Only).

The transport rate of hafnium was measured as a function of the temperature of the crude metal, the deposition temperature, and the HfI_4 vapor pressure. A maximum was obtained for a hafnium iodide vapor pressure of 0.7 torr. It was concluded from the investigation that below a total pressure of 0.35 torr, the reactions at the deposition wire were rate-determining, whereas the rate was determined by gas diffusion at higher pressures. The typical appearance of a maximum in the transport rate was, however, determined by thermochemical equilibrium conditions at the deposition wire. (auth) (Australia)

27827 (UCRL-19113) INTERSTITIAL ORDERING AND MECHANICAL PROPERTIES OF TANTALUM-CARBON ALLOYS. Rao, Prakash (California Univ., Berkeley. Lawrence Radiation Lab.). Dec 1969. Contract W-7405-eng-48. 120p. Dep. CFSTI.

Thesis.

Direct evidence for interstitial ordering in the tantalum-carbon system was obtained by transmission electron microscopy and field ion microscopy and was correlated with data on mechanical properties. Transmission electron microscopy indicated that the ordering transformation begins by fine scale fluctuations in carbon composition associated with the ⟨110⟩ planes. The fully ordered structure was realized locally when regions of ideal wavelength $\lambda = 4d_{110_{Ta}}$ were obtained. The alloy can be considered then to contain small ordered particles. These small ordered regions align themselves along ⟨110⟩ and grow until impingement. The final stage of the ordering transformation occurred with the formation of long range highly ordered regions separated by coherent domain boundaries. At this stage the alloys became totally brittle. Analyses of electron diffraction patterns of the ordered phase showed that at the critical carbon composition (1.56 at. %), the structure of the ordered phase corresponded to body centered tetragonal $Ta_{64}C$. Such a structure can be obtained by allowing carbon composition fluctuations to occur simultaneously along four sets of $\langle 110 \rangle_{Ta}$ planes such that $d_{110_C} = 4d_{110_{Ta}}$. At all other stages, only partial order existed. Confirmation of the ordering process was obtained from field ion microscopy whereby ordering can be detected even at 20°K by analysis of the imaging characteristics of atom rings around the ⟨110⟩ poles, with the aid of computer simulated field ion images expected from the ordered phase. Investigation of the mechanical properties of tantalum containing varying amounts of carbon (determined by ^3He activation analysis) at 300, 196, and 77°K showed that carbon caused a linear increase in yield strength and a decrease in ductility up to 1.56 at. %. At this point there was a sudden catastrophic loss in ductility. The linear dependence of yield stress on carbon composition reflected its dependence on the degree of order and on the volume fraction of the ordered phase. The onset of brittleness appeared to be due to the development of large scale ordered domains of $Ta_{64}C$. Certain restrictions were placed on the relationships between elastic compliances to determine whether an alloy was ductile or brittle. When the carbon composition attained a critical value the strain energy was so large that the restrictions on the compliances were no longer satisfied. Then the crystal became energetically unstable and failed along a set of planes which released the maximum amount of strain energy. This maximum strain energy was reached on the ⟨110⟩ planes, which are also the observed cleavage planes. The fact that interstitial ordering occurred at such small solute concentrations, as compared to substitutional alloys, means that the driving force must be due to the larger strain energy term resulting from the very large elastic deformations that occur. Since the $Ta_{64}C$ superlattice transformation was present in bulk material, a correction to the existing tantalum-carbon phase diagram is proposed. (62 references). (auth)

27828 (WAPD-TM-807) THE POROSITY CORRECTION FACTOR FOR THE THERMAL CONDUCTIVITY OF POROUS MATERIALS (LWBR DEVELOPMENT PROGRAM). Marino, G. P. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb 1970. Contract AT-11-1-GEN-14. 45p. Dep. CFSTI.

The variation of the porosity correction factor, β, with temperature and pore shape was studied by using the Fricke equation for the thermal conductivity of a two-phase medium containing the second phase as randomly distributed ellipsoids. Since the temperature variation occurred via the parameter $\gamma = K_{pore}/K_{100}$, the conductivity of the pores was also calculated for various gas contents in the pores. The thermal radiation contribution to pore

conduction was also included. The effect of pore shape was determined via the axial ratio, ϵ, of oblate or prolate ellipsoidal pores. The results are presented graphically in curves showing the variation of β with γ and ϵ. The above model was applied to actual conductivity data of ThO_2 and ThO_2-UO_2 specimens in an effort to correlate the general porous structure typical of ceramic fuels to the parameters (ϵ and γ) in the Fricke equation. It was shown that the β factor for ceramic fuels could be related to their general microstructure and pore conductivity in a self-consistent mathematical framework. The technique, therefore, minimized much of the guesswork heretofore required in estimating the porosity correction factor. (auth)

27829 STRENGTHENING OF TRANSITION METAL CARBIDES TO WITHSTAND DEFORMATION AT HIGH TEMPERATURES. Williams, Wendell S. (to Union Carbide Corp.). U. S. Patent 3,497,368. 24 Feb 1970. Filed 2 Jun 1964.

A method for strengthening transition metal carbides to withstand deformation at high temperatures is described. The invention relates particularly to the carbides of titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, and tungsten. Boron, in an amount between about 0.5% and 5%, is incorporated into the metal carbide in various ways, causing a hardening of the carbides at high temperatures while not adversely affecting the favorable room temperature hardness characteristics. (auth)

27830 EFFECT OF DISPERSION OF POWDERS ON THEIR SINTERING. Gropyanov, V. M. Ogneupory; No. 12, 46-52 (1969). (In Russian).

A study of the kinetics of sintering of ZrO_2, ZrC, and ZrB_2 showed that with an increase in specific surface of the initial powders, the degree of sintering improved. The activation energy of volume diffusion increased as a result of the decrease of the concentration of defects in crystallites during transition from roughly to finely dispersed powders. (tr-auth)

27831 THEORY OF THERMAL EXPANSION OF A GRAPHITE CRYSTAL IN THE SEMI-CONTINUUM MODEL. Kelly, B. T. (United Kingdom Atomic Energy Authority, Culcheth, Eng.); Walker, P. L. Jr. Carbon; 8: 211-26(Mar 1970).

A new theory of the principal thermal expansion coefficients of a graphite crystal was derived using lattice dynamics. The theory was compared with new data on the low temperature thermal expansion coefficients of very highly oriented pyrolytic graphite and high temperature x-ray data. Values of some of the lattice anharmonic coefficients are estimated. (auth) (UK)

27832 STRENGTH AND ELASTIC MODULUS RELATIONSHIPS IN BeO-SiC BODIES. O'Neill, J. S. (United Kingdom Atomic Energy Research Establishment, Harwell, Eng.). Trans. Brit. Ceram. Soc.; 69: 81-4(Mar 1970).

Submicron silicon carbide dispersed in beryllium oxide exerted a restraint on the grain-growth of the matrix during fabrication sintering and during extended subsequent anneals. Compacts of the composite densify during rapid heating to 1750°C and maximum density results when cooling is commenced as soon as this temperature is attained. Prolonging sintering time causes an increase in bend-strength in the bodies despite a tendency to lower density and from consideration of elastic modulus data it is concluded that extended sintering time causes the pore phase to become more spherical. The increase in strength of the porous body is shown to be related to the approach of the elastic modulus to that predicted by the Mackenzie relation and a modification of the Knudsen equation is proposed. (auth) (UK)

27833 HIGH-TEMPERATURE THERMODYNAMICS OF URANIUM CARBIDES. I. Nikol'skii, S. S. Teplofiz. Vys. Temp.; 7: 873-6(Sep-Oct 1969). (In Russian).

Four-parameter equations were obtained that described the activity of uranium and carbon as a function of the composition of solid solution UCy. These equations correspond formally to non-ideal solutions consisting of U, UC, and UC_2 in which the reaction $UC_2 + U \rightleftharpoons 2\ UC$ took place. (tr-auth)

27834 ELECTRIC CONDUCTIVITY AND PHASE COMPOSITION OF SOLID SOLUTIONS OF ZrO_2-CaO, ZrO_2-Y_2O_3, AND ZrO_2-CeO_2 AT 1000 TO 1700°C. Rutman, D. S.; Taksis, G. A.; Toropov, Yu. S.; Maurin, A. F. Ogneupory; No. 12, 34-41(1969). (In Russian).

Electric conductivity and phase composition of the systems ZrO_2-CaO, $ZrO_2-Y_2O_3$, and ZrO_2-CeO_2 were studied at 1000 to 1700°C in air. The maximum electric conductivity of ZrO_2-CaO and $ZrO_2-Y_2O_3$ was found to depend on additions of 12 to 13 mole % of calcium oxide and 8 to 11 mole % of yttrium. In the ZrO_2-CeO_2 system, a gradual increase in electric conductivity was proportional to an increase in cerium oxide content from 10 to 50 mole %. With an increase in temperature, the abnormal values of electric conductivity, with optimum additions of calcium and yttrium oxides, slowly reduced and at 1700°C and additions of 7 to 35 mole %, electric conductivity depended slightly on composition. In the system $ZrO_2-Y_2O_3$, a composition close to stoichiometry corresponded to minimum electric conductivity. (tr-auth)

27835 COMPATIBILITY EFFECTS OF SUPERSTOICHIOMETRIC URANIUM CARBIDE WITH REFRACTIVE METALS TANTALUM, NIOBIUM, AND MOLYBDENUM IN THE TEMPERATURE RANGE OF 1200 TO 1600°C. Coen, V.; Kolbe, H.; Quataert, D. (EURATOM-CCR, Ispra, Italy). Met. Ital.; 61: 556-66(Nov 1969). (In Italian).

The compatibility between arc melted uranium carbide with a carbon content of $4.80 < C < 5$ wt % and the refractory metals Ta, Nb, Mo has been studied in the temperature range 1200 to 1600°C. The reaction layers have been analyzed and the phase formed identified. An interpretation of the mechanism of the reactions is given. (auth)

27836 STUDIES ON FUNDAMENTAL PROPERTIES OF ALUMINA ADSORBENT FOR RADIOISOTOPE PRODUCTION. Takahashi, Satoko; Shikata, Eiji; Amano, Hiroshi (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo); 7: 130-6(Mar 1970).

Properties of a commercially available chromatographic alumina, used for the preparation of radioisotope generators and for the separation of fission products, were examined in connection with certain pretreatment procedures. It showed an increase in its adsorption capacity and a decrease in alumina dissolution, when ignited for 10 hr at 400°C and treated thereafter with boiling dilute hydrochloric acid. When treated by the above procedure, the properties of the alumina in respect to dissolution and adsorption capacity were found to be unaffected by extended periods of storage under conditions corresponding to normal operation. The pretreated alumina was made into column form. The dissolution of alumina with various kinds of eluants and the adsorption capacity for chloride, sulfate, fluoride, tellurite, tellurate, and molybdate ions were examined. The dissolution of alumina differed according to eluant, the sequence from larger to smaller dissolution being sodium hydroxide, hydrochloric acid, nitric acid, ammonium hydroxide and sodium chloride. It was also observed that the adsorption capacity and the elution conditions for tellurium and molybdenum were greatly affected by the pH of the solution and their valency. (auth)

27837 PROPERTIES OF VARIOUS BeO POWDERS AND THEIR SINTERABILITY. Hattori, Takeo; Suzuki, Hiroshige (Tokyo Inst. of Tech.). Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 90, 91-104(Mar 1969).

The results showed that the most sinterable BeO powder is obtained when the aggregates are loosened by being slightly crushed after the sulfate is thermally decomposed and calcined at an adequate temperature. The shrinkage of the initial sintering of the sinterable BeO powder proceeded linearly as a function of time. (NSA of Japan)

27838 THE SINTERING BEHAVIOUR OF URANIUM DIOXIDE UNDER CONTROLLED OXYGEN POTENTIAL. Jakeshova, L. (Imperial Coll. of Science and Tech., London. Inst. of Nuclear Research, Prague). Phys. Sintering; 2: 33-45(Jan 1970).

The influence of small variations in oxygen pressure on the sintering behavior of UO_2 powder compacts was studied at oxygen partial pressures of 10^{-14}, 10^{-10}, and 10^{-9} atm. These pressures correspond to about $UO_{2.000}$, $UO_{2.002}$, and $UO_{2.014}$, respectively, with a final temperature of 1135°C. It was found that small deviations from stoichiometry drastically influenced the sintering rate up to 75 to 85% of the total linear shrinkage. Difference in the substructure and agglomerate structure of the starting powders survived the chemical changes during the heating-up process and had an effect on the sintering behavior of compacts at a constant temperature. (J.C.W.)

27839 REDUCTION OF SOME MIXED OXIDES, MO_2 WITH TiO_2. Kahn-Harari, Andree; Thery, Jeanine (CNRS, Vitry, France). Compt. Rend., Ser. C; 270: 761-4(2 Mar 1970). (In French).

The behavior of some mixed oxides, MO_2 with TiO_2, with classical reducing agents (H_2,CO) was studied. Two examples are considered: non-reducible MO_2 oxides (ZrO_2, HfO_2, or ThO_2) and reducible MO_2 oxides (CeO_2). (auth) (France)

27840 EQUILIBRIUM STUDIES IN THE TERNARY SYSTEMS Zr-C-H, Zr-N-H, AND Zr-O-H. Goretzki, H.; Petzow, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 1.15.1-15 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in

Stuttgart, vom 8. bis 10. Mai 1968. Band I. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.1).

In the systems Zr-C-H, Zr-O-H, and Zr-N-H equilibria between gaseous hydrogen and its ternary solid solutions were determined by means of Sieverts apparatus. The partial molar enthalpies and entropies of the dissolved hydrogen were calculated from the pressure-concentration isotherms. The heats of solution deviated only a little from the literature results of the α-Zr-H-solution. Due to ordering effects, the entropies of solution were lower than for the α-Zr-H-solution. The change of lattice parameter with hydrogen concentration was examined by x-ray techniques. (auth)

27841 2. EUROPAEISCHES SYMPOSIUM UEBER PULVERMETALLURGIE, IN STUTTGART, VOM 8. BIS 10. MAI 1968. BAND Ia. (Second European Symposium on Powder Metallurgy, Stuttgart, 8-10 May 1968. Volume Ia). Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). 325p. (In several languages). (CONF-680504-(Vol.1a)).

A total of 22 papers was presented at the conference and included in Volume Ia. A separate abstract was prepared for each of 14 papers. The remaining 8 papers were not within the scope of NSA. (G.M.C.)

For abstracts of individual papers see: 27742-27745, 27775-27779, 27793, 27815, 27816, 27842, and 27878.

27842 CREEP BEHAVIOR OF ALUMINUM-ALUMINA (SAP) ALLOYS. Bonnet, P.; Kellerer, H.; Piatti, G.; Schleicher, H. W. pp 2.2.1-21 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.1a).

The creep behavior of Al-Al_2O_3 alloys was studied at 450°C for times-to-rupture between 10 min and 1000 hrs. Tests were concentrated mainly on SAP containing 7% oxide. The results exhibited a relatively high scatter. In order to clarify the mechanism of the process density measurements were made on the creep samples in different zones. Electron micrographs were prepared as well. On the basis of these tests the creep behavior of SAP could be related to high rate of crack formation depending on the nature of the Al-Al_2O_3 interface. (auth)

27843 INVESTIGATIONS ON STABLE AND UNSTABLE DISPERSIONS OF URANIUM COMPOUNDS AND METALS. Ondracek, G.; Thuemmler, F. pp 5.1.1-20 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band II. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2).

For a comparison of stable and unstable cermets the systems UO_2-Cu and U_3O_8-Al were studied. The free enthalpies of the probable reactions and temperature relations are given. For U_3O_8-Al measurements were made of the heats of reaction corresponding to the most probable sequence of reactions. Increased transformation caused a rise in porosity. Tensile tests and elasticity measurements showed considerable differences between the two systems, demonstrating the great influence of the phase boundaries. (auth)

27844 INVESTIGATIONS IN THE FIELD OF DISPERSION STRENGTHENING AND REINFORCEMENT OF POWDER METALLURGY METAL-BASE ALLOYS. Frantsevich, I. N.; Karpinos, D. M.; Kondratev, Yu. W.; Tuchinskii, L. I. pp 5.3.1-30 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band II. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2).

The investigation of dispersed inclusion compatibility with Mo and W as function of vacuum annealing temperature while using the methods of metallography, electron microscopy, and x-ray structural analysis revealed complete lack of ZrO_2 interaction with both metals. For all other compounds an increase of lattice parameters indicated the presence of dissolving processes of compounds components, and in the systems W-MgO and Mo-ZrN formation of new compounds $WMgO_4$ and Mo_2N was established. Independently of interaction character, but to different extent, dispersed inclusions decreased grain growth during recrystallization. In dispersion-strengthened Mo-5vol % ZrN and Mo-5vol % ZrO_2 alloys increased strength was obtained at 1000°C approximately 4 and 3 times, respectively, in comparison with commercial forged Mo. Strengthening effect was levelled to 1700°C. A number of technological factors of metal reinforcement with more refractory metallic fibers was investigated. The reinforcement of nickel with tungsten fibers resulted in materials with strengths at 1100°C of 7 to 10 times that of pure nickel. The calculation methods for the thermal stresses, appearing in reinforced materials as a result of differences in elastic constants and coefficients of linear expansion of the matrix and the fibers are recommended for cases of elastic and elastic and/or plastic deformations of the components. (auth)

27845 2. EUROPAEISCHES SYMPOSIUM UEBER PULVERMETALLURGIE, IN STUTTGART, VOM 8. BIS 10. MAI 1968. BAND IIa. (Second European Symposium on Powder Metallurgy, Stuttgart, 8-10 May 1968. Volume IIa). Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). 300p. (In several languages). (CONF-680504-(Vol.2a)).

A total of 20 papers was presented at the conference and included in Volume IIa. A separate abstract was prepared for each of 16 papers. The remaining 4 papers were not within the scope of NSA. (G.M.C.)

For abstracts of individual papers see: 27747, 27780, 27781, 27820, 27821, 27846-27851, and 27879-27883.

27846 ON THE QUESTION OF THE GROWTH OF STRUCTURE COMPONENTS IN WC-Co ALLOYS WITH SMALL (Ta,Nb)C CONTENTS. Walter, P.; Grewe, H. pp 7.5.1-20 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2a).

The growth of the structure-components in WC-Co cemented carbides with small (Ta, Nb)C contents was determined by annealing tests. For investigation of the growth of the components, measurements of hardness, metallographic examinations, and changing of coercive force were used. It was shown that the growth of structure-elements in alloys with small (Ta, Nb)C contents was noticeably impeded compared with (Ta, Nb)C-free alloys. (auth)

27847 THE Co-WC-TiC-TaC SYSTEM: COMPOSITION-PROPERTY-PERFORMANCE RELATIONS DETERMINED WITH MINIMAL EXPERIMENTATION. Turnbull, J. C. (Firth Sterling Corp., Pittsburgh). pp 7.7.1-16 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2a).

A method of minimal experimentation and graphic data handling is described for defining relations between compositions and properties of ternary and quaternary systems. Application of the method to the important cemented carbide system, Co-WC-TiC-TaC, is illustrated as an example. The graphical method was based on the common ternary and quaternary diagrams. Seven experimental compositions were shown to be adequate to define the composition-property relations of a ternary system; fifteen were shown to be adequate for a quaternary system. Performance relations are included through application of the British Hard Metals Association system of classification of hard metal grades for machining. (auth)

27848 NEW INVESTIGATIONS ON THE PLASTIC BEHAVIOR AND THE BREAKING PROCESSES IN REFRACTORY METALS. Burbach, J. (Fried-Krupp GmbH, Essen). pp 7.13.1-30 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2a).

The investigations of the deforming and breaking behavior of cemented carbides were based on the use of an extremely hard upsetting tool (press) for conducting the compression tests. With this test set-up it was possible to determine, practically without error, the deforming and breaking behavior of less ductile materials. All tested WC-Co alloys (containing 6 to 30 wt % Co) showed, prior to the breakage of the specimen, a distinctly measurable plastic deformation which grew as the Co-content and the mean WC grain size increased and was distributed over the two phases. The elastic energy stored in the specimen was insufficient to cause an existing or incipient crack to propagate immediately to a specimen breakage. On the contrary, a crack propagation, accompanied by a distinct reduction in yield stress, took place prior to the specimen breakage when the energy delivered by the upsetting tool was sustained. Besides the usual

brittle fractures, the broken specimen showed shear faces covered with a W, C, and Co-bearing layer whose structure was not yet determined. (auth)

27849 REMARKS ON THE TOUGHNESS TESTING OF CEMENTED CARBIDES BY MEANS OF THE CRACK LENGTH METHOD. Exner, H. E.; Petzow, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 7.14.1-19 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2a).

Contrary views exist regarding the influence of surface preparation on the formation of cracks at Vickers indentations, which is used by Palmqvist as a method for testing the toughness of cemented carbides. The experimental results gave a clear answer to this question, which was essential for the use and interpretation of the crack length method. Grinding diminished the thermal tensile stresses in the cobalt phase reducing the crack length. By polishing, the deformed surface layer was removed and a stress pattern was approached which corresponded to the stress state present in the bulk material. Cracks of maximum length were characteristic for this state. The deformation stresses could be removed by annealing at temperatures above 800°C. On the basis of this concept sample preparation for the crack length method can be simplified. The accuracy of measurement is improved and a simple and significant parameter for the crack resistance of cemented carbides is found. (auth)

27850 INFLUENCE OF VELOCITY ON THE WEAR OF CARBIDE AND OXIDE SINTERED MATERIALS. Dawihl, W.; Klingler, E. (Univ., Saarlandes, Ger.). pp 7.15.1-33 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2a).

The wear resistance of cemented carbides and of sintered alumina was related to the sliding velocity and impact resistance. (auth)

27851 INVESTIGATIONS OF MgO–UO_2 AND Al_2O_3–UO_2 DISPERSIONS. Claussen, N.; Petzow, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 8.2.1-15 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2a).

Concentration dependence of different properties of the nuclear fuel dispersions MgO–UO_2 and Al_2O_3–UO_2 was determined. Results obtained from sintered and hot-pressed samples showed that there existed good bonding between phases in both systems. This was actually not expected, expecially not in MgO–UO_2 dispersions, because of the relatively large difference in thermal expansion coefficients. The good phase bonding was also verified by comparing Young's Modulus and indirect tensile strength for 50% fracture probability with the curves calculated for ideal bonding. The plot of the homogeneity factor stated that the probability for fracture to occur far below the mean strength was higher in hot-pressed Al_2O_3–UO_2 samples than in the sintered ones. (auth)

27852 THERMAL DIFFUSIVITY OF PYROLYTIC ZIRCONIUM DIBORIDE AT HIGH TEMPERATURES. Neshpor, V. S.; Fridlender, B. A.; Sharupin, B. N. (Leningrad State Inst. of Applied Chemistry). Inzh.-Fiz. Zh.; 18: 527-30(Mar 1970). (In Russian).

The results of measuring thermal conductivity at 1500 to 2300°C of high-heat zirconium diboride obtained by chemical gas-phase precipitation are presented. (auth)

27853 PERMEABILITIES OF HELIUM AND DEUTERIUM THROUGH A BOROSILICATE GLASS. Walters, L. C. (Sandia Labs., Albuquerque, N. Mex.). J. Amer. Ceram. Soc.; 53: 288-9 (21 May 1970).

The permeabilities of helium and deuterium through a borosilicate glass were measured with a mass spectrometer. It was found that permeability was sensitive to the thermal history of the sample. (G.M.C.)

27854 SYNTHESIS AND INVESTIGATION OF PROPERTIES OF COMPLEX RARE EARTH OXIDES AND HAFNIUM OXIDES. Portnoi, K. I.; Timofeeva, N. I.; Salibekov, S. E.; Romanovich, I. V. Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 91-5(Jan 1970). (In Russian).

Rare earth oxide and hafnium oxide compounds were obtained by thermal decomposition of nitrate salts in air at 1200°C. All rare earth and hafnium oxide compounds of the form $R_2O_3 \cdot 2HfO_2$ were investigated except for cerium and promethium. Density, melting points, thermal conductivity, coefficients of linear thermal expansion, microhardness, chemical stability, and the structure were studied. The reactions of HfO_2 and the oxides of the rare earth metals led to the formation of two types of oxide structures-pyrochlorite and fluorite. The synthesized oxides were refractory, stable in a wide temperature range, and had high chemical stability in HCl, HNO_3, CH_3OOH, H_2O, NaOH, NH_4OH, H_2SO_4, H_3PO_4, $HClO_4$, and HF. (tr-auth)

27855 INVESTIGATION OF TEMPERATURE FIELDS OF MELTS FOR MONOCRYSTAL GROWTH OF BaO–B_2O_3 AND PbO–PbF_2–B_2O_3. Perfilova, V. E.; Bodyachevskii, S. V.; Avvakumova, L. A.; Derman, A. S. (All-Union Scientific Research Inst. of Electric Welding Equipment, Leningrad). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 100-3(Jan 1970). (In Russian).

Temperature fields were measured for BaO–B_2O_3 and PbO–PbF_2–B_2O_3 melts in a solution of V_2O_3–Fe_2O_3. Heat conductivity and free convection zones were established in the melts. (tr-auth)

27856 DIFFUSION OF OXYGEN IN CeO_2 MONOCRYSTALS. Vinokurov, I. V. (Inst. of Chemistry of Silicates, Leningrad). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 31-6(Jan 1970). (In Russian).

A new method is proposed for the measurement of the coefficient of diffusion of oxygen in oxides which are not stoichiometric and form F-type color centers in alkali halide crystals. The diffusion of oxygen was studied in monocrystals of CeO_2 and CeO_2 alloyed with gadolinium. The studies showed that with the introduction of gadolinium into the lattice of CeO_2, the coefficient of the diffusion of oxygen increased greatly and the energy of activation of the diffusion process decreased. (tr-auth)

27857 PECULIARITIES OF REACTIONS OF V_2O_5, MoO_3, AND WO_3 WITH CARBON AND CARBON OXIDES. Elyutin, V. P.; Pavlov, Yu. A.; Polyakov, V. P.; Sheboldaev, S. B. (Moscow Inst. of Steel and Alloys). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 37-40(Jan 1970). (In Russian).

The peculiarities of the reactions of V_2O_5, MoO_3, and WO_3 with carbon and carbon oxides were considered and it was observed that the reduction of the metal oxides by these reducing agents was different. The reduction of the metal oxides by carbon was realized by the transfer of oxide vapor onto the surfaces of the reducing agent. The thermally unstable oxides of V_2O_5 and MoO_3 reacted with carbon more easily than the less volatile oxide of WO_3. The temperatures of the beginning of the reduction of the metal oxides by the carbon oxides were close to the temperatures of the beginning of isotopic exchange of oxygen in the lattices of these oxides. The beginning of the reaction was related to the sharp increase of the rate of oxygen diffusion in the lattices of the metal oxides. (tr-auth)

27858 X-RAY FLUORESCENCE ANALYSIS OF THIN FILMS OF V_3Si. Bashkirov, Yu. A.; Denker, B. I. (Lebedev Inst. of Physics, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 20-4(Jan 1970). (In Russian).

Spectral calculations were made on V–Si films up to 1 micron and the results agreed with experimental measurements by x-ray spectrometry. With greater thicknesses, the calculations produced lower results. Experimental spectral results allowed the determination of the composition of the film with ±0.05 wt % accuracy and its thickness with ±0.05 micron accuracy. (tr-auth)

27859 HIGHLY REFRACTORY CERAMICS OF CALCIUM AND STRONTIUM ZIRCONATES. Doluboyarinov, D. N.; Demidova, Zh. N. (Moscow Chemical-Technological Inst.). Ogneupory; No. 11, 34-40(Nov 1969). (In Russian).

Conditions for sintering of calcium and strontium zirconates were studied, technology for the production of ceramics from these materials was developed, and the properties were determined. Several granular structures of the ceramics were prepared and thermomechanical properties were studied. (tr-auth)

27860 PRODUCTION OF HIGHLY REFRACTORY PRODUCTS FROM STRONTIUM ZIRCONATES AND HAFNATES. Belik, V. Ya. Ogneupory; No. 11, 48-50(Nov 1969). (In Russian).

Sintered porous briquets of strontium hafnate and zirconate were obtained by heating at 1600 and 1750°C. After pressing and sintering, granular masses from $SrZrO_3$ and $SrHfO_3$ were studied and properties of small products from these masses were determined. (tr-auth)

27861 COLLECTIVE RECRYSTALLIZATION IN FREELY POURED POWDERS OF ZIRCONIUM CARBIDE. Samsonov, G. V.; Boshko, S. A. Porosh. Met., Akad. Nauk Ukr. SSR; No. 3, 35-8(Mar 1970). (In Russian).

It was established that in freely poured powders of nonstoichiometric phases of zirconium carbide the activation energy of the collective recrystallization decreased with an increase in the imperfection of carbon sublattice. The growth of the activation energy from TiC_x to NbC_x and further to ZrC_x was in agreement with the type of electronic interaction in these phases. (auth)

27862 EFFECT OF DEGREE OF MELTING OF ZIRCONIUM DIOXIDE ON ITS ADHESION IN PLASMA COATING. Zakharov, B. M.; Trofimov, M. G. (All Union Scientific-Research Inst. of Aviation Materials, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR; No. 3, 51-6(Mar 1970). (In Russian).

It was established that the magnitude of the adhesion strength of coatings depended to a considerable extent on the degree of particle melt. Adhesion strength and thermal resistance of the coating grew with the increase of the heat exchange zone in the burner nozzle and power of the arc and with the decrease of the distance up to the back. The distance was 70 mm for the surfaces of 1X18119T alloy that did not undergo cooling and 45 mm for those undergoing cooling. (auth)

27863 EFFECT OF NICKEL, COBALT, AND COPPER ADDITIVES ON KINETICS OF WO_3 REDUCTION WITH CO. Lambiev, D. K.; Stoyanova, S. H. (Inst. of Electrical Engineering Metaloceramics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 22: 1245-8(1969).

The kinetics of the reduction of pure WO_3 by CO were investigated in the range of 700 to 1000°C at 50° intervals. The reduction was found to be diffusion-controlled. The particle size of the reduction product was dependent on temperature but was independent of the specific reducing agent. The effects of nickel, cobalt, and copper additives on the reduction rate of WO_3 with CO at 700 to 900°C and the granulometric composition of the final reaction product were determined. (G.M.C.)

27864 STRENGTH-ANISOTROPY-GRAIN SIZE RELATIONS IN CERAMIC OXIDES. Kirchner, H. P.; Gruver, R. M. (State Coll., Philadelphia). J. Amer. Ceram. Soc.; 53: 232-6(21 May 1970).

On the basis of high strengths observed at small grain size and crack formation observed at moderate grain size, a large grain-size dependence of the strength of rutile ceramics was predicted. This dependence was investigated by experiment, and a grain-size exponent greater than $-\frac{1}{2}$ was found. Tabulating literature data on the grain-size dependence of strength and the degree of anisotropy of several oxide ceramics demonstrated a correlation between the degree of anisotropy and the grain-size exponents; the grain-size exponent increased with increasing anisotropy. The mechanism of fracture of single-phase ceramics composed of anisotropic crystals is discussed. (auth)

27865 ELASTIC PROPERTIES OF POLYCRYSTALLINE THULIUM OXIDE AND LUTETIUM OXIDE FROM 20° TO 1000°C. Manning, W. R.; Hunter, O. Jr. (Iowa State Univ., Ames). J. Amer. Ceram. Soc.; 53: 279-80(21 May 1970).

The Young's and shear moduli of polycrystalline thulium oxide (Tm_2O_3) and lutetium oxide (Lu_2O_3) were determined from 20 to 1000°C using the sonic resonance method. (G.M.C.)

27866 STABILIZATION OF CUBIC ZrO_2 BY MnO AND PARTIAL SUBSTITUTION OF Ti, Nb, OR Ta FOR Zr. Bayer, Gerhard (Eidgenoessische Technische Hochschule, Zurich). J. Amer. Ceram. Soc.; 53: 294(21 May 1970).

It was possible to replace part of the Zr(IV) ions in stabilized ZrO_2 by cations with identical or higher valences which had a strong preference for octahedral oxygen coordination, i.e., Ti(IV), Nb(V), and Ta(V) ions. Up to 50 mole % ZrO_2 in MgO-stabilized ZrO_2 was replaced by TiO_2 with a resultant large decrease in lattice constant. It was also found that cubic ZrO_2 could be stabilized by MnO in a neutral atmosphere by heating it to 1550°C. (G.M.C.)

27867 ALUMINA AS A CERAMIC MATERIAL. Gitzen, Walter H. (ed. and comp.). Columbus, Ohio; American Ceramic Society (1970). 262p. $16.00.

A comprehensive survey was compiled to provide a sourcebook for aluminum oxide ceramic technology. The features and characteristics of high-temperature, transition, and hydrated aluminas are presented in detail, and are adequate for both engineering and scientific reference. Subjects discussed include nomenclature, natural occurrence and associations, beneficiation and preparation techniques, crystallographic features, and mineralogical properties. Mechanical, thermal, sonic, electrical, magnetic, optical, radiation (nuclear), chemical, and colloidal properties are critically reviewed. The aspects of grinding, forming, and sintering pertinent to the production of refractories and other applications including uses in glass, cement, cermets, electrical insulation, thermal coatings, and airborne equipment are given. An extensive bibliography is provided. (auth)

Structure and Phase Studies

27868 (AERE-R-6052) NEUTRON DIFFRACTION STUDY OF CARBON FIBRES. Sinclair, R. N.; Wedgwood, A.; Harris, D. H. C.; Egelstaff, P. A. (Atomic Energy Research Establishment, Harwell (England)). Jun 1969. 18p. Dep. CFSTI (U. S. Sales Only). UK 3s. 6d.

A preliminary survey of carbon fibres by neutron diffraction has been made. Wide-range data were taken using a time-of-flight diffractometer which exhibited peaks extending from 002 reflection to the 60 band of reflection. The crystal size was determined from the width of the peaks. A set of angular distribution measurements was made on both bundles of fibres and on composites of fibres and resin, using a conventional (fixed wavelength) diffractometer. These measurements gave the c-axis orientation function of the fibres. Finally, ultra small angle scattering measurements were made to look for defects in the fibres, and these showed the need to correct the data for refraction by a bundle of fibres: the residual effect due to defects being quite small. (auth) (UK)

27869 (EUR-4136) STUDIES ON THE TERNARY SYSTEM UO_2-U_3O_8-PuO_2. Benedict, U.; Sari, C. (European Atomic Energy Community, Karlsruhe (West Germany). Transuranium Inst.). 14 May 1969. 38p. Dep. CFSTI (U. S. Sales Only). EUR FF 6.65.

Sintered pellets of uranium–plutonium mixed oxides with Pu/U + Pu ratios from 5 to 90 % were oxidized under appropriate oxygen partial pressures at different temperatures. The oxidized samples were analyzed by ceramography and x-ray diffraction. The results were used to construct the partial U–Pu–O phase diagram for O/U + Pu ≥ 2.00 at room temperature, 600, 1 000, and 1 400° C. At room temperature a two phase region MO_{2+x} + M_4O_9 was observed with O/M up to 2.20 and Pu/U + Pu ≤ 0.30. A single phase M_4O_9 type existed with O/M between 2.20 and 2.27. This phase did not show a superlattice as reported for U_4O_9. With increasing temperature the two phase region became smaller. At 1 400° C a single fluorite phase existed for all Pu concentrations and O/M up to 2.27. Above O/M = 2.27 and for overall Pu/U + Pu ratios below 0.5, a plutonium-rich fluorite phase was in equilibrium with a uranium-rich orthorhombic U_3O_8-type phase. When oxidation took place at 600° C a metastable phase of the tetragonal U_3O_7 type was formed for Pu/U + Pu < 0.25 and O/M ≤ 2.28, and no segregation of plutonium occurred between the U_3O_8-type phase and the fluorite phase, because cation diffusion was too slow at that temperature. The oxidation limit in air was determined for all compositions and temperatures studied. The pattern of the U_3O_8 structure was completely indexed with reference to its pseudohexagonal form, and the dependence of its lattice parameters from oxygen and plutonium content was studied. (auth)

27870 (GEMP-734) SOLIDUS AND LIQUIDUS TEMPERATURES IN THE UO_2–ThO_2 SYSTEM. Latta, R. E.; Duderstadt, E. C.; Fryxell, R. E. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Apr 1970. Contract AT(40-1)-2847. 7p. Dep. CFSTI.

Thermal arrest measurements of the solidus and liquidus temperatures were taken for the ThO_2–UO_2 system in the range of 0 to 17% ThO_2. Special attention was given to stoichiometry control during specimen preparation. (G.M.C.)

27871 ANOMALOUS THERMAL EXPANSION OF ZrO_2 AND HfO_2 OVER THE RANGE 20 TO 1200°C. Filatov, S. K.; Frank-Kamenetskii, V. A. (Leningrad State Univ.). Sov. Phys.-Cryst. (Engl. Transl.); 14: 696-9(Mar-Apr 1970).

Translated from Kristallografiya; 14: 804-8(Sep-Oct 1969).

The unit cell parameters, the thermal expansion coefficients along the crystallographic axes, the principal components of the thermal expansion α_1, α_2, and α_3, and their orientation were determined for monoclinic ZrO_2 and isostructural HfO_2 by high-temperature diffractometry using powder diagrams. The expansion of both compounds is highly anisotropic: $\alpha_3 > \alpha_1 > \alpha_2 \sim 0$. In the case of ZrO_2 the anisotropy $\alpha_3 > \alpha_1$ is increased in the region of the monoclinic–tetragonal transformation (1150–1250°C) where $\alpha_1 \to 0$ and $\alpha_3 \to$ VEC (volume expansion coefficient), the angle between α_3 and [001] increasing from 29 to 45°. The phase transformation is accompanied by a structural contraction of 3.42%. The anomalous nature of the thermal expansion is discussed in relation to the monoclinic–tetragonal transformation, and from this point of view may be attributed to anomalous phase transitions. (auth)

27872 NEUTRON-DIFFRACTION STUDY ON ZIRCONIUM CARBOHYDRIDE. Bykov, V. N.; Golovkin, V. S.; Kalinin, V. P.;

Levdik, V. A.; Shcherbak, V. I. Sov. Phys.-Cryst. (Engl. Transl.); 14: 785-6(Mar-Apr 1970).
Translated from Kristallografiya; 14: 913-15(Sep-Oct 1969).

The structure of $ZrC_{0.3}H$ was studied using 1.22-Å neutrons. The hexagonal structure from x-ray diffraction was used as the original model; the space group was found to be P3m1. The structure was found to be complex due to selective localization of the C atoms, which occupy only one of alternating octahedral layers. Along the Z axis, the tetrahedra expand and contract alternatively, while the degree of occupation of H atoms in the reduced voids of the layer with C octahedra is one-third of the degree in the layer with empty octahedra. A small fraction of the empty octahedra is occupied by H atoms. (D.L.C.)

27873 GROWTH OF PORES IN GRAPHITIZED CARBON REACTED WITH CARBON DIOXIDE. Kalback, W. M.; Brown, L. F.; West, R. E. (Univ. of Colorado, Boulder). Carbon; 8: 117-24 (Mar 1970).

Cylinders of a very pure graphitized porous carbon were reacted to 10, 20, and 30 % burnoff at 1030°C. Based upon pore size distributions obtained from the unburned carbon and from radial sections of the cylinders at each percentage burnoff, the major portion of early pore development apparently occurred by preferential burning of single crystallites of carbon. This yielded pores of approximately the same size as the original carbon crystallites. These pores reached a maximum volume, whereupon further development in this range of pore sizes ceased. Burning away of the walls of the larger pores then became the major portion of the reaction. (auth) (UK)

27874 STRUCTURE AND PROPERTIES OF TANTALUM CARBIDE CRYSTALS. Rowcliffe, D. J.; Warren, W. J. (Lockheed Palo Alto Research Lab., Calif.). J. Mater. Sci.; 5: 345-50(Apr 1970).

Single crystals of tantalum carbide, up to 2 mm in size have been grown from solution in a bath of molten iron. The slip plane was found to be {111} using a two-surface analysis on etch-pitted crystals deformed by microindentation at room temperature. Observations of etch-pit patterns around inclusions suggest that slip occurs on other planes at elevated temperatures. Maximum microhardness values between 3800 and 5200 Knoop (100 gm load) were found at a composition $TaC_{0.83\pm0.01}$. In regions of crystals with a carbon content less than $TaC_{0.83}$ a phase transformation was seen close to microhardness indentations in samples decarburized below 2200° C. The mechanical behavior of tantalum carbide is discussed with reference to a general model for the electronic structure of carbides. (auth) (UK)

27875 X-RAY STUDY ON A PHASE TRANSITION AND A PHASE DIAGRAM IN THE U_4O_9 PHASE. Ishii, T. (Tokyo Univ.); Naito, K.; Oshima, K. Solid State Commun.; 8: 677-83 (May 1970).

The transition temperature in U_4O_{9-y} was found to be dependent on quenching condition as well as O/U composition. It changed from 4 to 100°C and the magnitude of lattice contraction during the transition increased with decreasing O/U composition. It was also found by x-ray diffraction that U_4O_{9-y} has a fairly wide range of homogeneity between 800°C and room temperature. (auth) (UK)

27876 STUDIES ON THE Ni–Nb–O SYSTEM AND ON THE EQUILIBRIUM OF REDUCTION OF NICKEL NIOBATE. Abbattista Fedele; Tkatchenko, Evgheni} Victorovitch; Chiantaretto, Giampaolo. Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 103: 605-25(Jul-Oct 1969). (In Italian).

The phase diagram of the Ni–Nb–O system at a temperature of 1250°C was determined by means of the study of the reduction equilibrium and x-ray tests. The two nickel niobates $4NiO \cdot Nb_2O_5$ and $NiO \cdot Nb_2O_5$ can exist in equilibrium either with elementary Ni or with NiO and a partially reduced phase of the Nb_2O_5 type. The niobate $NiO \cdot Nb_2O_5$, obtained by reduction with metallic Ni and simultaneously with all the phase series, contained oxygen pockets of the type that occurs in the binary system Nb_2O_5–NbO_2. On the basis of the results obtained, considerations were developed on the oxidation resistance of Nb–Ni alloys in relation to the constitution of the protective layers formed on the metal surface. (tr-auth)

27877 STUDIES ON COPPER URANATE. Montorsi, Margherita Appendino. Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 103: 689-95(Jul-Oct 1969). (In Italian).

The solid state equilibrium at a temperature of 800°C was studied in the system U_3O_8–Cu_2O–O. In addition to the previously known copper uranates CuU_3O_{10} and $CuUO_4$, a previously unknown copper uranate was obtained. The formula Cu_2UO_4 was attributed to it. It was established that in the zone of the system among U_3O_8, UO_2, CuO, and Cu_2O, there are five triphases in which the following compounds can coexist, respectively: U_3O_8, CuU_3O_{10}, and $CuUO_4$; $CuUO_4$, U_3O_8, and Cu_2UO_4; Cu_2UO_4, U_3O_8, and Cu_2O; $CuUO_4$, Cu_2UO_4, and CuO; and finally CuO, Cu_2UO_4, and Cu_2O. (tr-auth)

27878 STRUCTURAL CLARIFICATION OF Co–W–Cr–C–Si ALLOYS. Knotek, O.; Seifahrt, H. pp 3.5.1-10 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band Ia. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).
From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.1a).

The Co-rich corner in the Co–Cr–W–C–Si system was studied. An isothermal section with constant C and Si content of 1% was examined at 1050°C. In order to determine the single phases, the samples melted in an induction furnace were examined metallographically and by X-rays. Apart from the transitions of the connecting systems (Co–W–C–Si and Co–C–Cr–Si), no additional phases appeared in comparison with Si-free alloys of the same composition at the same homogenizing temperature. Besides the α-modification of the Co, the carbide phases of the type MC, M_7C_3, $M_{23}C_6$, and M_6C as well as the intermetallic δ-phase were secured. Microprobe examinations will be used in order to confirm the metallic and metalloid behavior of the Si according to its position in the periodic system. (auth)

27879 CHARACTERIZATION OF COMMERCIAL REFRACTORY METAL AND METAL CARBIDE POWDERS. Riley, R. E. (Los Alamos Scientific Lab., N. Mex.). pp 7.1.1-31 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969).
From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.2a).

Complete characterization, including morphology, is essential to the successful and economical use of powders in powder metallurgy fabrication processes. The importance of metallographic examination cannot be overemphasized in the evaluation of other characterization data in the development of procurement specifications. Much of the trial and error could be eliminated through a better understanding and usage of powder characterization data. It was also shown that by classing a powder into a specific morphological type of microstructure, it was possible with some degree of predictability to show a correlation between such parameters as average particle size and specific surface with the density of green and sintered compacts. A dense discrete particle (Type B), as a function of grain size, offered some degree of predictability relative to sintered density. The aggregate particle (Type C) was less predictable because it was dependent upon the size of the individual particles which made up the aggregate. (auth)

27880 NbC- AND HfC-CONTAINING CERAMICS AND REFRACTORY METALS. Kieffer, R.; Trabesinger, G. pp 7.2.1-13 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).
From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.2a).

Both the TiC–TaC–NbC–WC and the TiC–HfC–WC systems were investigated by roentgenography. In the 4-component system, a quaternary mixed crystal, free WC, and a two-phase system were observed. At 2400°C a maximum solubility of 91 wt % WC in the mixed crystal was obtained. In the 3-component system a previously undescribed three-phase system as well as 3 two-phase regions were observed. The substitution of NbC for TaC in WC–TiC–TaC refractories was favorable only up to 30%. HfC can completely replace the TaC in the system. The use of a NbC–HfC mixture in place of TaC also gives good results. (tr-auth)

27881 COBALT IN CARBIDES OF REFRACTORY METALS. Peter, W.; Jung, O.; Kohlhaas, E. (Roechling'sche Eisen- und Stahlwerke GmbH, Voelklingen, Ger.). pp 7.4.1-12 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).
From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504–(Vol.2a).

Measurements of cobalt content in WC, TiC, and WC–TiC–TaC crystals with the microprobe analyser gave an insight into basic sintering processes of hard metals. Submicroscopical cobalt layers were enclosed in the carbide lattices and later, partly eliminated by diffusion. Heating tests confirmed this interpretation. Even at high temperatures cobalt was not dissolved in TiC. The determined cobalt residues in WC and WC–TiC–TaC were either dissolved or the enclosed layers were so fine that they could be eliminated even by a long acid attack. (auth)

27882 INVESTIGATIONS OF AUTOMATIC MEASUREMENTS OF THE SPACIAL MICROSTRUCTURE OF REFRACTORY METAL STRUCTURES BY MICROPROBES AND PHASE INDICATORS. Doerfler, G. (Univ., Vienna). pp 7.12.1-16 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In German).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2a).

By means of some examples of refractory materials it was demonstrated that the electron microprobe in combination with the phase integrator was especially suitable for stereometric analysis. The example of a stereometric analysis of a TiC-TaC-WC-Co cemented carbide revealed the variation of the different structural parameters with the annealing time at a temperature of 1600°C. The determination of the three-dimensional grain size distribution of carbides in a high-speed tool steel was demonstrated. (auth)

27883 GRAIN GROWTH IN SINTERED UO_2 OF DIFFERENT POROSITY. Petrovic, V.; Sigulinski, F.; Stevanovic, M. (Boris Kidric Inst. of Nuclear Science, Belgrade). pp 8.3.1-25 of 2. Europaeisches Symposium Ueber Pulvermetallurgie, in Stuttgart, vom 8. bis 10. Mai 1968. Band IIa. Duesseldorf, Ger.; Ausschuss fuer Pulvermetallurgie (1969). (In French).

From 2nd Powder Metallurgy Symposium, Stuttgart, Germany. See CONF-680504-(Vol.2a).

UO_2 compacts differing in porosity were obtained by sintering under hydrogen at 1000 to 1600°C. Polished and etched surfaces were studied by micrography in an He atmosphere. The isothermal curves of grain growth were related to the analytical data. The phenomena of grain growth in polycrystalline porous ceramics, of grain boundary migration and of interactions between grain boundaries and pores were investigated. From these findings and experimental results conclusions are drawn on the effect of pores on grain boundary migration and grain growth in sintered UO_2. (auth)

27884 ELECTRON-MICROSCOPIC INVESTIGATIONS ON UO_2-SiO_2 MATRICES AT VARIOUS URANIUM DIOXIDE CONCENTRATIONS. Glanz, G.; Teodorescu, I. (Inst. of Atomic Physics, Bucharest). J. Nucl. Mater.; 34: 221-3(Feb 1970). (In German).

Various amounts of uranium dioxide were mixed with silicon dioxide and sintered. The product was studied under the electron microscope. Results showed that uranium dioxide and silicon dioxide formed a binary system. Only a small amount of the uranium dioxide, less than 1%, was dissolved in the silicon dioxide phase. (H.B.G.)

27885 SOME INVESTIGATIONS FOR CLARIFICATION OF DISCREPANCIES IN EQUILIBRIUM MEASUREMENTS IN THE U(CN)-C-N_2 OR U(CN)-UC_2-N_2 SYSTEMS. Naoumidis, A. (Kernforschungsanlage, Juelich, Ger.). J. Nucl. Mater.; 34: 230-3(Feb 1970). (In German).

Uranium oxide and uranium carbide were pulverized in a highly purified argon atmosphere, mixed with various amounts of graphite, and compressed into pellets. These pellets were heated to 2000°C under a nitrogen atmosphere and then cooled under vacuum. Determination of crystal constants was done by Debye-Scherrer diagrams, metallographic studies, and chemical analysis. Oxygen impurities were found to have no significant influence on crystal structure. Discrepancies with earlier findings were explained by the method of heating. Heating of the furnace by induction current also heated the samples directly and produced a higher temperature in the interior than on the surface. (H.B.G.)

27886 CERAMOGRAPHY OF URANIUM-PLUTONIUM OXIDES, PART II. HIGH TEMPERATURE FIRED UO_2-PuO_2 DISPERSION. Sari, Carlo; Tebaldi, Vittorio (European Inst. for Transuranium Elements, Karlsruhe, Ger.). Prakt. Metallog.; 7: 146-52(Mar 1970). (In German and English).

The ceramographic analysis of pellets of plutonium oxide dispersions in uranium oxide is reported. According to the overall oxygen content, different structures were revealed by chemical and vacuum cathodic etching. (auth)

27887 LOW-TEMPERATURE MODIFICATION OF MOLYBDENUM CARBIDES. Eremenko, V. N.; Velikanova, T. Ya.; Listovnichii, V. E.; Komarova, S. A. (Inst. of Problems of Science of Materials, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 11-14(Jan 1970). (In Russian).

The phase transition of Mo_2C took place at 1170 ± 13°C. The transition was followed by an exothermic effect during cooling and was characterized by considerable temperature hysteresis. A distortion in crystalline lattice symmetry was also observed for Mo_2C. (tr-auth)

27888 SYSTEMS BeF_2-YF_3 AND KF-BeF_2-YF_3 WITH 5 MOLE PERCENT KF. Borzenkova, M. P.; Galina, V. N.; Novoselova, A. V. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 25-30(Jan 1970). (In Russian).

A phase diagram was constructed for BeF_2-YF_3 from the results of thermal and x-ray analyses. Studies were made on the section of the system of KF-BeF_2-YF_3 with constant (5 mole percent) content of KF. (tr-auth)

27889 RELATION OF INTERIONIC DISTANCES IN SESQUIOXIDES OF RARE EARTH ELEMENTS. Krestov, G. A.; Krestova, N. V. Zh. Neorg. Khim.; 15: 299-304(Feb 1970). (In Russian).

The temperature coefficients and the interionic distances in sesquioxides of the rare earth metals and the ionic components were determined at various temperatures. The interionic distances from 298.15 to 2000°K were found for La_2O_3, Ce_2O_3, Nd_2O_3, Sm_2O_3, Eu_2O_3, Gd_2O_3, Dy_2O_3, Ho_2O_3, Er_2O_3, Tm_2O_3, Yb_2O_3, and Lu_2O_3. (tr-auth)

27890 SYSTEM MoO_3-ZrO_2. Ustinov, O. A.; Andrianov, M. A.; Chebotarev, N. T.; Novoselov, G. P. Zh. Neorg. Khim.; 15: 582-3(Feb 1970). (In Russian).

The phase composition of sintered MoO_3-ZrO_2 was studied by x-ray analysis in the range of concentration from 0 to 100 mole % ZrO_2. The melting point of $Zr(MoO_4)_2$ was found to be 1060°C. The phase diagram of MoO_3-ZrO_2 was in good agreement with the results of x-ray and thermographic investigations obtained previously. (tr-auth)

27891 PHASE RATIOS IN Nd_2O_3-SrO SYSTEM. Tresvyatskii, S. G.; Pavlikov, V. N.; Lopato, L. M.; Lugin, L. I. (Inst. of Problems of Science of Materials, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 41-5(Jan 1970). (In Russian).

The phase ratios in the system Nd_2O_3-SrO were studied by annealing and quench hardening at 1500 to 2350°C. The phase diagram was constructed. Three new compounds identified were $2Nd_2O_3 \cdot SrO$; $4Nd_2O_3 \cdot 5SrO$; and $2Nd_2O_3 \cdot 3SrO$. The compounds with ratios of 2:1 and 2:3 were stable in the entire temperature range and melted congruently. The compound with the ratio 4:5 had a limited existence at 1730 to 1850°C. The stabilization of the high-temperature modifications of neodymium oxide was not discovered. (tr-auth)

27892 INVESTIGATION OF Ho_2O_3-Nb_2O_5 SYSTEM. Krylov, E. I.; Krivonosov, L. B.; Leont'ev, S. A. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 46-9(Jan 1970). (In Russian).

The binary system Ho_2O_3-Nb_2O_5 was studied by x-ray analysis. The compound Ho_3NbO_7 with the cubic structure of fluorite was discovered where a = 5.23 Å and holmium orthoniobate was discovered with the monoclinic structure of fergusonite where a = 5.049 Å, b = 10.902 Å, c = 5.240 Å, β = 94°30'. The formation of the compound Ho_3NbO_7 is explained by its similarity to the structures of fluorite, pyrochlorite, and the cubic structure of Type-C rare earth oxides. (tr-auth)

27893 CHANGE IN STRUCTURE AND PROPERTIES OF HEATERS MADE OF MOLYBDENUM DISILICIDE AT HIGH-TEMPERATURE. Kislyi, P. S.; Badyan, A. Kh.; Kharchenko, V. K.; Shvab, S. A. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 3, 96-9(Mar 1970). (In Russian).

A change in porosity, grain size of $MoSi_2$ and ultimate bending strength was studied in the process of high-temperature heating of heaters of molybdenum disilicide. Recommendations are given on optimum conditions of using heaters. (auth)

27894 PHASE TRANSITION IN α-U_3O_8 AT 210°C. Loopstra, B. O. (Reactor Centrum Nederland, Petten, Netherlands). J. Appl. Crystallogr.; 3: 94-6(1970).

The structure of α-U_3O_8 above the transition point at 210°C was determined from neutron powder diffraction data. It was found to be very similar to the structure at room temperature. Contrary to experimental evidence, theory does not allow a second order phase transition from the structure at high temperature (space group P62m) to that at room temperature (space group C2mm). (auth)

27895 ON THE STRUCTURAL AND MORPHOLOGICAL RELATIONSHIPS BETWEEN THE VO_x AND β-VANADIUM SUBOXIDES IN THE TWO-PHASE SYSTEM. Cambini, M. (CCR-EURATOM, Petten, Netherlands). Mater. Res. Bull.; 5: 287-300 (May 1970).

The 3.6 wt% oxygen composition of the vanadium-oxygen system consisted of two different tetragonal suboxides, namely the VO_x (c/a = 0.962) and the β-vanadium(c/a = 1.085), in closely related crystallographic orientation. By electron microscopy and

electron diffraction, the crystallographic and structural relations were found to be: $[110]VO_x/[011]\beta$, $d(110)VO_x = d(011)\beta$, $a\beta = c_{VO_x}$. Using gold as an internal standard, accurate lattice spacings of the two phases in close contact were obtained by electron diffraction VO_x: a = 3.11$_4$Å, c = 2.99$_8$Å; β: a = 2.99$_6$Å, c = 3.25$_2$Å. The volumes of the vanadium sublattice unit cells of the two suboxides were the same within the experimental errors. X-ray data are consistent with the above statements. The two phases gave rise either to an alternating lamellar structure in which the interphase boundaries were of the type $(110)VO_x/(011)\beta$, or to a chessboard type structure in which, in addition to the $(110)VO_x/(011)\beta$ and $(110)VO_x/(101)\beta$ boundaries, $(011)VO_x$ and $(101)VO_x$ twins are also present. Evidence is presented that the β phase, for this composition, is derived from the oversaturated VO_x phase upon cooling. This transformation was crystallographically equivalent to a shear transformation on the four systems $(110)[1\bar{1}0]$, $(110)[\bar{1}10]$, $(110)[1\bar{1}0]$ and $(1\bar{1}0)[\bar{1}10]$ of VO_x. (auth)

27896 BORON–SCANDIUM SYSTEM. Peshev, P.; Etourneau, J.; Naslain, R. (CNRS, Tallence, France). Mater. Res. Bull.; 5: 319-28(May 1970). (In French).

The boron-scandium system was studied in a large range of temperature (1200 to 2200°C) and composition ($2 \leq B/Sc \leq 100$) by borothermic reduction of Sc_2O_3 under high vacuum. Only two borides, ScB_2 and ScB_{12} with a definite composition, were obtained. ScB_2 had a AlB_2 structure; it sublimated without decomposition above 1800°C in a 10^{-6} torr vacuum. ScB_{12} did not have the previously reported UB_{12} structure; its powder pattern and density agreed with the tetragonal cell proposed by Matkovich et al.; it melted congruently at 2040 ± 50°C. For high B/Sc ratios a solid solution of scandium in β-rhombohedral boron was obtained. The existence of ScB_4 and ScB_6 was not confirmed. (auth)

27897 POLYMORPHIC BEHAVIOR OF THIN EVAPORATED FILMS OF ZIRCONIUM AND HAFNIUM OXIDES. El-Shanshoury, I. A.; Rudenko, V. A.; Ibrahim, I. A. (Atomic Energy Establishment, Cairo). J. Amer. Ceram. Soc.; 53: 264-8(21 May 1970).

Polymorphism in thin evaporated films of zirconium and hafnium oxides was investigated from 100 to 1500°C by electron diffraction and transmission electron microscopy. The films have metastable cubic structures at room temperature and at moderate temperatures. Zirconium oxide, depending on temperature, existed in cubic, tetragonal, and monoclinic forms, whereas hafnium oxide transformed directly from the cubic to the monoclinic structure. The transformation temperatures depended on the oxygen partial pressure. Air annealing of thin films of ZrO_2 and HfO_2 lowered the temperature of transformation of the tetragonal and the cubic structure into the monoclinic structure by about 150 and 100°C, respectively. The cubic/tetragonal transformation of ZrO_2 was monotropic, whereas the tetragonal/monoclinic transformation occurred by the typical nucleation and growth mechanism. Determination of grain size in ZrO_2 at the tetragonal/monoclinic transformation temperature showed that the transformation occurred when a constant grain size of about 800 Å was reached. The oxygen partial pressure, grain size, and temperatures at which the metastable phases existed were correlated. The rate of grain growth was enhanced by increase in oxygen partial pressure. The accelerated transformation in air was attributed to rapid attainment of the critical size; grain boundary energy was an important controlling factor in transformation. (auth)

Radiation Effects

Refer also to abstracts 27102, 28857, 28984–28987, 29012, and 29093.

27898 INTERPRETATION OF DIMENSIONAL CHANGES CAUSED IN PYROLYTIC CARBON BY HIGH-FLUENCE NEUTRON IRRADIATION. Bokros, J. C.; Koyama, K. (Gulf General Atomic Inc., San Diego, Calif.). J. Appl. Phys.; 41: 2146-55(Apr 1970).

Dimensional changes in a variety of pyrolytic carbons irradiated at 900 to 1000°C and at 1200 to 1300°C showed that during the irradiation, the rate at which the specimens change dimensions accelerated. The accelerations were most pronounced in dense, isotropic carbon and were accompanied by the generation of pores in the structure, which caused a volume expansion. The data obtained at the lower irradiation temperatures (~900°C) suggested that the accelerations were due primarily to a degradation in crystal structure that enhanced the instability of the crystallites. At the higher irradiation temperatures, increases in anisotropy contributed significantly to the accelerations. The volume expansions, the degradation of the crystal structure, and changes in thermal conductivity were all less for irradiations above 1200 than at 1000°C. These observations, together with the increases in anisotropy, are believed to be manifestations of the fact that the intercrystallite irradiation creep rate is substantially higher at irradiation temperatures above 1200 than at 1000°C. High creep rates provided an effective mechanism which relaxed the stresses that were generated between adjacent, misaligned crystallites during irradiation. (auth)

Plastics and Other Materials

Refer also to abstracts 27140–27142 and 27306.

27899 (BDX–613–125) CHARACTERIZATION OF AN EPOXY FOAM. McIlroy, H. M.; Smith, C. H. (Bendix Corp., Kansas City, Mo.). [nd]. Contract AT(29-1)-613. 23p. Dep. CFSTI.

A review of several of the mechanical, electrical, and thermal properties of a one-component rigid epoxy foam system indicated that the foam meets many of the requirements for an embedment material for electronic components. Because of the excellent fluidity, long pot life, and convenient packaging of the premix, many production and processing problems are reduced. The mechanical and electrical properties plus the thermal stability of the cured foam appear to make this epoxy foam a prime candidate for foamed-in-place electronic potting and encapsulation applications. (auth)

27900 (KURRI-TR-65) IRRADIATION STUDIES AT DRY ICE TEMPERATURE IN PNEUMATIC TUBE AND SLANT TUBE OF KUR. (Kyoto Univ. (Japan). Research Reactor Inst.). [1969]. 15p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

Mechanical properties of polyethylene capsules which were utilized in the irradiation facilities of KUR (i.e., Pneumatic Tube and Slant Tube) were studied, and irradiation of the capsules at dry ice temperature was tried. Irradiation-induced radioactivities, radioisotopes, and changes of mechanical strength of the capsules irradiated at reactor power 1 MW were detected, experimentally. Weight changes of dry ice in the capsule and the temperature change in the capsule filled with dry ice were measured under some conditions. From the results of above experiments, it was concluded that the irradiation of the samples in the polyethylene capsule at dry ice temperature can be performed safely without any damages on both the reactor and the irradiation facilities. (auth)

27901 (RFP–1424) GLOVEBOX WINDOW MATERIALS. Jacoby, Charles W. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 13 Mar 1970. Contract AT(29-1)-1106. 16p. Dep. CFSTI.

Coated Plexiglas, Homalite 101B polyester clear transparent sheet, and Zelux W polycarbonate clear transparent sheet have been evaluated and found to have good resistance to detrimental conditions commonly found in plutonium recovery areas. Of these materials, polycarbonate was considered to be the safest and will be the primary plastic window material used in plutonium recovery areas at Rocky Flats. (auth)

27902 CRYSTAL STRUCTURE OF STOICHIOMETRIC URANIUM DITELLURIDE. Haneveld, A. J. Klein; Jellinek, F. (Rijksuniversiteit, Groningen, Netherlands). J. Less-Common Metals; 21: 45-9(1970).

The structure of stoichiometric uranium ditelluride, UTe_2, was determined by x-ray powder methods. The compound is orthorhombic, space group Immm; a = 4.1617; b = 6.1276; c = 13.695 Å. Uranium is coordinated by eight tellurium atoms (average distance U–Te = 3.17 Å) forming a trigonal prism with two capped, square faces. Half of the tellurium atoms form infinite straight chains with Te–Te distances of 3.06 Å. β-$ErSe_2$ is probably isostructural with UTe_2. (auth)

27903 COATING PROCESS INVOLVING RADIATION CURING OF COATING. (to Ford Motor Co. Ltd.). British Patent 1,191,011. 6 May 1970. Priority date 1 Jul 1966, United States.

A method of coating an object is described. A liquid layer of a coating material such as styrene or divinyl benzene, capable of polymerization by exposure to radiation is applied to the surface of a flexible thin film. The coated surface of the thin film is applied to the surface of the object to be coated. The combination of the coated object and the thin film is exposed to electron irradiation of sufficient intensity to polymerize the coating material at low temperature. The process may be used to alternately apply and cure successive thin coatings on metal, wood, glass, and synthetic polymeric solids. (J.C.W.)

27904 THERMAL DECOMPOSITION OF HOLMIUM, ERBIUM, AND YTTERBIUM NITRATES. Dvornikova, L. M.; Sevost'yanov, V. P.; Ambrozhii, M. N. (Saratov State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 12: 1163-7(1969). (In Russian).

Use was made of chemical, thermographic, and x-ray structural analyses for studying the process of thermal decomposition of the aqueous nitrates of holmium, erbium, and ytterbium. A tendency to lower decomposition temperatures was observed in these salts in the sequence Ho, Er, and Yb. The compositions of the starting intermediate and end products of calcination were determined and are tabulated. X-ray structural analysis of holmium nitrate showed that the initial product is crystalline. A Debye diagram of the product calcined at 380°C showed the lines of two phases: the initial nitrate and the oxide. The lattice was greatly distorted. In the Debye diagram of the product fired at 480°C the number of nitrate lines was reduced. At 580°C the Debye diagram showed a defective fine-crystalline structure of holmium oxide. As the temperature was raised to 700°C and higher, the crystals became larger and the structure became ordered, showing a clear interference pattern of a sesquioxide of cubic shape of C. The analyses of both erbium nitrate and ytterbium nitrate are described and the results interpreted.(JPRS)

PHYSICS (GENERAL)

Astrophysics and Cosmology

27905 SPACE ENVIRONMENT. Langton, N. H. (ed.). Space Research and Technology, Volume 1. New York; American Elsevier Publishing Company, Inc. (1969). 245p. $7.00.

This book deals with the environmental aspects of space flight. After a brief history of astronautics, the atmospheric structure of the planets and temperatures in space are discussed. Radiation, radiation protection, meteoroid hazards to spacecraft, and requirements for manned space flight are considered. A separate abstract was prepared for the chapter on radiation and radiation protection. (D.L.C.)

For an abstract of one chapter see: 27596.

Cosmic Ray Exposure Ages

27906 GOLD AND IRIDIUM IN METEORITES AND SOME SELECTED ROCKS. Ehmann, W. D.; Baedecker, P. A.; McKown, D. M. (Univ. of Kentucky, Lexington). Geochim. Cosmochim. Acta; 34: 493-507(Apr 1970).

Gold and iridium abundances in stony meteorites and various meteoritic and terrestrial materials have been determined by the technique of neutron activation. Gold abundances in chondrites reported here and by Baedecker and Ehmann (1965) are in generally good agreement with published data of other workers. Compilation of all available gold data yields the following group averages (in units of 10^{-9}g/g): C1-140, C2-177, C3-184, Enstatite-322, H-group-228, L-group-162, LL-group-167. Iridium data were obtained by use of an improved radiochemical separation technique and also a nondestructive technique employing gamma-gamma coincidence spectrometry. Evidence is presented that some earlier iridium determinations via radiochemical separations may be subject to significant analytical error. Iridium concentrations for the various chondrite groups as determined by the nondestructive coincidence technique of this work are (in units of 10^{-9}g/g): C1-490, C2-608, C3-645, Enstatite-618, H-group-781, L-group-453, LL-group-371. The significance of the meteorite data to the life history of these objects is discussed, with particular reference to the metal-silicate fractionation process during the formation of the chondrites. (auth) (UK)

Stars

Refer also to abstract 28296.

27907 OBSERVATION OF A FLARE IN THE BLUE VARIABLE G44-32. Warner, B.; Van Citters, G. W.; Nather, R. E. (Univ. of Texas, Austin). Nature (London); 226: 67-8(4 Apr 1970).

The faint blue proper-motion variable star G44-32 was monitored using a photomultiplier tube operated at the Cassegrain focus of the 82 in. Struve reflector at the McDonald Observatory, together with appropriate electronic and computing equipment. It was confirmed that G44-32 is a variable star of small amplitude, and observations made on Feb. 7, 1970 are reported, at which time the star displayed a sharp and unexpected increase in brightness believed due to flare activity. The sudden rise was followed by a rapid initial decay and then a gradual decrease to the pre-flare light level. It is thought that flare activity of this sort has not previously been reported in objects of this type, and G44-32 is suspected to be a white dwarf. Flares are relatively common among the dwarf M stars, but the blue colour of G44-32 shows that it is not of this class. The possibility cannot be excluded, however, that the blue object might have a fainter red companion that contributes little to the total light in general, but which might be the seat of the flare activity. (UK)

27908 DUST IN SUPERNOVA EXPLOSIONS. Hoyle, F.; Wickramasinghe, N. C. (Cambridge Univ., Eng.). Nature (London); 226: 62-3(4 Apr 1970).

There is considerable evidence that supernovae can be caused by explosive ignition of degenerate material in evolved stars. Explosive carbon burning produces elements ranging from Ne to Si, and silicon burning produces elements from P to Ni, and the relative abundances of elements produced in both processes are similar to the observed solar values, which supports the view that supernova explosions are a major source of enrichment of the interstellar medium in heavy elements. The possibility is discussed that a significant fraction (say 10%) of the mass of these heavy elements condenses into solid particles during the expansion phase following explosion. In addition to producing observable effects on supernova light curves, such solid particles could make a significant contribution to the mass density of grains in the interstellar medium. The material produced through C or Si burning may be assumed to expand adiabatically from an initial density $\sim 10^{31}$ nucleons/cm^3 and an initial temperature of $\sim 10^{10}$K. When T falls to ~2000°K molecules form, and as T falls further from 2000°K, thermodynamic conditions are favorable for the formation of solid particles comprising silicates and metallic iron and 10% of the expanding material would be expected to have condensed out in solid form after about a year from the explosion. The radius that can be attained by a grain is calculated. The opacity remains high until ~ 30 yr or longer after the explosion. Dielectric grains diffuse the light but graphite and metallic grains absorb it. It may be that supernovae constitute a major source of silicate iron and graphite grains. It is found that the rate of increase of mass density of interstellar grains throughout the volume of the Galaxy is $\simeq 7 \times 10^{-38}$ g/cm^3 yr giving a density of $\simeq 7 \times 10^{-27}$ g/cm^3 over $\sim 10^9$ yr, a value which is close to that estimated on the basis of most grain models. (UK)

27909 LMC CLUSTERS NGC 2010 AND NGC 2136. Gascoigne, S. C. B.; Hearnshaw, J. B. (Australian National Univ., Canberra). Proc. Astron. Soc. Aust.; 1: 208-9(Mar 1969).

Preliminary color-magnitude diagrams were obtained for Cepheid variable stars in NGC 2010 and NGC 2136, from blue and yellow 40-inch plates with photoelectric calibration to V ≃ 18. (W.D.M.)

27910 SPECTRUM VARIATIONS IN 56 ARIETIS. II. NEW OBSERVATIONS OF SILICON AND HELIUM LINES. Bonsack, Walter K. (Univ. of Hawaii, Honolulu); Wallace, William A. Publ. Astron. Soc. Pac.; 82: 249-73(Apr 1970).

Spectrum line intensity and wavelength measurements were made on 95 spectrograms of this Ap-type spectrum variable, sampling 1100 cycles of variation. Measurements of the He I lines at 4471 and 4026 Å, and the Si II lines at 3954, 4076, 4128-31, and 4201 Å support a model in which the stellar surface contains two distinct regions in which the He I lines are strong, and three to five regions in which the Si II lines are strong. The spectrum variation occurs as these are carried through the visible hemisphere by rotation with a period of 0.728d. No evidence is found for phase shifts or other changes in the period. Superimposed on the regular variation are irregular increases of the line strength in both elements. The width of the Mg II line at 4481 Å is in accord with a rotation of the stated period if the star is seen equator-on. A digital summing procedure used on a few of the spectrograms led to the tentative identification of the lines of multiplet 44 of S II, varying in strength with silicon. (auth)

27911 ULTRASHORT-PERIOD VARIABLES AND THE MASSES OF BLUE STRAGGLERS IN THE OLD DISK POPULATION. Eggen, O. J. (Australian National Univ., Canberra). Publ. Astron. Soc. Pac.; 82: 274-92(Apr 1970).

An examination of the nine small-amplitude, ultrashort-period variables assigned to the Hyades group, including one newly discovered (HR 3586), shows that they are divided into two luminosity groups with no apparent period-luminosity relation. A search for similar stars in the old disk population revealed one (HD 6870) new variable in the σ Puppis group. It is concluded from the space motions and, in a few cases, membership in stellar groups that ultrashort-period variables of all amplitudes occur in both the young and old disk populations and there is no strong argument that they, as well as the other blue stragglers in the old disk population, are not stars of 1.5 to 2.5$_\odot$, in the shell hydrogen-burning stage of their evolution. (auth)

27912 INTERSTELLAR REDDENING OF RR LYRAE. McNamara, D. H.; Helm, T. M.; Wilcken, S. K. (Bringham Young Univ., Provo, Utah). Publ. Astron. Soc. Pac.; 82: 293-8(Apr 1970).

Photometric observations (uvbyβ and khg) of twelve field stars near RR Lyrae are used to derive an accurate value of the interstellar reddening of the variable. The average color excess determined from three different calibrations is E(b - y) = 0011m or E(B - V) = 0016m. The reddening-free $(B - V)_{min}$ value of RR Lyrae is compared with the average $(B - V)_{min}$ value of eleven RR Lyrae stars of similar period at high galactic latitudes. The results indicate that the average reddening near the north galactic pole is extremely small. (auth)

27913 RADIAL VELOCITY OF ARCTURUS DETERMINED FROM INTERFEROMETRIC SPECTRA. Bopp, Bernard W.; Edmonds, Frank N. Jr. (Univ. of Texas, Austin). Publ. Astron. Soc. Pac.; 82: 299-305(Apr 1970).

From high-resolution, infrared, interferometric spectra, the radial velocity of Arcturus is determined by simple measurements between superposed spectral tracings of the star and the Sun. A velocity of -5.47 ± 0.07 km/sec obtained from metal lines is comparable to a highly accurate result obtained by Petrie and Fletcher (1967) using standard methods. A velocity of -5.82 ± 0.18 obtained from CO lines is interpreted in terms of a differentially expanding atmosphere. (auth)

27914 ON THE MOTIONS OF GAS AND DUST IN NGC 2068. Stockton, Alan; Chapman, Gary (Univ. of Hawaii, Honolulu. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac.; 82: 306-12(Apr 1970).

The spectrum of the diffuse nebula NGC 2068 (M 78) is composite, showing nebular emission lines as well as the scattered spectrum of the illuminating star. The difference in radial velocity between the emission and absorption spectra is ~100 km/sec; this difference can be interpreted as resulting from the expansion of the dust cloud about the central star. (auth)

27915 PHOTOMETRIC AND SPECTROSCOPIC OBSERVATIONS OF AG AND HR CARINAE. Bond, Howard E. (Louisiana State Univ., Baton Rouge); Landolt, Arlo U. Publ. Astron. Soc. Pac.; 82: 313-20(Apr 1970).

Photometric and spectroscopic observations are presented for the two P Cygni-like slow variable stars AG and HR Carinae. (auth)

27916 NEW PECULIAR STARS NOTED ON OBJECTIVE-PRISM PLATES. Bond, Howard E. (Louisiana State Univ., Baton Rouge). Publ. Astron. Soc. Pac.; 82: 321-8(Apr 1970).

A list of previously unknown peculiar stars noted during an objective-prism survey is given. Included are 51 Ap, 33 Am, two Bp, and two Ba II stars, two G–K stars showing strong Ca II emission, and a new, relatively bright CH star. The distribution of galactic latitudes of the Ap Si stars in the survey region suggests that the silicon stars are related to the late B-type stars, and have not evolved from the early B stars. (auth)

27917 WY GEMINORUM: AN ECLIPSING SYSTEM. Cowley, Anne (Univ. of Michigan, Ann Arbor. Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac.; 82: 329-33(Apr 1970).

Spectroscopic evidence suggests that WY Geminorum has recently suffered an atmospheric eclipse. It is possible that the star may have also undergone a photometric eclipse. A comparison with the spectroscopic features of VV Cephei is made. (auth)

27918 SPECTRA OF THE CEPHEID HR 8157. Abt, Helmut A.; Levy, Saul G. (Kitt Peak National Observatory, Tucson, Ariz.). Publ. Astron. Soc. Pac.; 82: 334-8(Apr 1970).

This small-amplitude Cepheid, newly discovered by Millis, is a member of a known, closely spaced visual system with a possible period of 30 years. The velocity curve of the Cepheid is also of small amplitude and with a mean velocity that varies with time, probably due to motion in the visual system. No features in the blue violet or filling in of the absorption lines are definitely attributable to the visual companion. Nevertheless, there is hope that continued study of the system will lead to a determination of the Cepheid's mass. (auth)

27919 DIFFERENTIAL UBV PHOTOMETRY OF β LYRAE. I. Lovell, Larry P.; Hall, Douglas S. Publ. Astron. Soc. Pac.; 82: 345-9(Apr 1970).

Between June 1968 and Sept. 1969 36 UBV observations were made of the well-known eclipsing binary β Lyrae with a 10-inch f/13 cassegrain reflector. Results are briefly reported here, and the authors anticipate a series of papers from future observations over an extended period. (W.D.M.)

27920 THE K LINE IN ALGOL. Ebbighausen, E. G. (Univ. of Oregon, Eugene). Publ. Astron. Soc. Pac.; 82: 349-51(Apr 1970).

The spectra of components A and C in the triple spectroscopic system Algol ABC have been observed but not that of B. An attempt to observe a broad K line of Algol B is described. It is concluded that the K line originates in Algol C. (W.D.M.)

27921 HR 8880: A LOW-AMPLITUDE DELTA SCUTI STAR. Millis, Robert L.; Thompson, Don T. Publ. Astron. Soc. Pac.; 82: 352-5(Apr 1970).

Photoelectric observations made on Nov. 5, 1969 with the 24-inch reflector at Lowell Observatory revealed a variation in the magnitude difference between HR 8880 and HR 8905. The variability of HR 8880 was confirmed at the 72-inch Perkins reflector on Nov. 18, 1969 when two comparison stars were employed in the observations. (W.D.M.)

27922 EVIDENCE FOR THE EXISTENCE OF HEAVY NUCLEI PRIOR TO THE S-PROCESS. Zeh, H. D. (Univ., Heidelberg). Nature (London); 225: 361-2(24 Jan 1970).

A definite correlation exists between the abundances and neutron capture cross sections of nuclei above the Fe abundance peak, demonstrating that these nuclei must have been formed by a neutron capture process with a time scale slow compared with β-decay times (the s process). Theories of stellar nucleosynthesis assume that these s-nuclei were formed by neutron irradiation of pre-existing iron peak nuclei as "seed." The empirical abundance distribution, however, indicates a genetic relationship between s and other heavy nuclei abundance components; this can be understood by assuming that about one-third of all presently existing non-s nuclei have been exposed after formation to a neutron flux of $\sim 0.25 \times 10^{27}$ n/cm^2. Such a hypothesis explains the overall behavior of the s-component abundance distribution, which is understandable from irradiation of iron peak nuclei alone only by assuming rather artificial distributions of neutron flux. The empirical abundances of ^{206}Pb, ^{207}Pb, and ^{208}Pb cannot be attributed solely to the s-process. For ^{208}Pb, non-s contributions are negligible, but it has been argued that the increase of the product of abundance and cross section between mass numbers 204 and 206 is due to a large contribution from the β component, either directly through α decay of unstable progenitors between Bi and Th, or by cosmoradiogenic decay of ^{235}U and ^{238}U. The contribution of α decay from mass 210 during the s-process (α-cycling) can be neglected since the capture cross section of ^{210}Pb is very small. These findings, however, are in conflict with empirical element abundances, and particularly those found in Type-I carbonaceous chondrites, which are considered reliable representatives for solar system abundances of nongaseous elements. An experimental upper limit of about 25% for the non-s contributions of ^{206}Pb and ^{207}Pb can be derived from the empirical ^{209}Bi abundance. Separate determinations of the contributions from cosmoradiogenic decay and from decay of short-lived progenitors lead to slightly lower values. An estimate of the contribution from unstable β-progenitors requires information on the level of the β-abundances above the Pt peak, leading to the result that the β-component can scarcely have contributed more than 15% of ^{206}Pb and ^{207}Pb. It is concluded that it seems unlikely that known non-s components can explain the deviation from a monotonically decreasing curve. A slow neutron capture process can explain this feature only by association with a corresponding maximum in the pre-existing need; an appropriate maximum is known to exist in the β-component in the vicinity of ^{194}Pt. A similar feature is predicted to occur in the Ba isotopes, where cross section determinations are still missing. (UK)

27923 SPECTROPHOTOMETRIC INVESTIGATION OF THE STAR MWC 334. Chkhikvadze, Ya. N. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR; 57: 321-4(Feb 1970). (In Russian).

Identification and determination of intensities of emission lines were carried out and it was found that $V_r = -50$ km/sec. The energy distribution in the continuum spectrum was investigated. The changes, discovered in the spectrum, are interpreted by assuming that MWC 334 is a hot star (Sp. BO–B1) surrounded by a variable nebula. The mass of the nebula is estimated as equal to $0.57 \cdot 10^{-4} M_\odot$. (auth)

27924 ELECTRON TEMPERATURE OF THE PLANETARY NEBULA IC 418. Le Marne, A. E.; Shaver, P. A. (Univ. of Sydney). Proc. Astron. Soc. Aust.; 1: 216-17(Mar 1969).

Observations were made at 408 MHz with digital recording on magnetic tape; 5 such observations of IC 418 were averaged and a flux density of 0.17 f.u. was obtained. An attempt to determine the electron temperature from this flux density is described. (W.D.M.)

27925 FORBIDDEN LINES AND ELECTRON TEMPERATURES IN GASEOUS NEBULAE. Aller, L. H. (Univ. of California, Los Angeles); Czyzak, S. J. Proc. Astron. Soc. Aust.; 1: 218-19 (Mar 1969).

Electron temperatures of planetary nebulae are discussed along with the neon ion lines to determine the temperature. It is concluded that stratification effects, differences in electron tempera ture, and density from point to point in the nebula must all be taken into account in any realistic treatment of the problem. (W.D.M.)

27926 MASS LOSS FROM RAPIDLY ROTATING EVOLVING B-STARS. Meyer-Hofmeister, E.; Thomas, H.-C. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Astron. Astrophys.; 5: 490(May 1970).

Results on mass loss caused by rotational instability are presented for a 9 $M_\odot$ star evolving off the main sequence. (auth)

27927 CONSEQUENCES OF WEAK INTERACTIONS FOR STELLAR EVOLUTION. Heintzmann, H. (Institut fuer Theoretische Physik, Cologne). Astron. Astrophys.; 5: 488-9(May 1970).

On the basis of a classical model field theory, upper limits for possible weak interactions between baryons are derived. The consequences of such forces are investigated for stellar evolution. It turns out that such weak forces are only important for white dwarf and neutron stars. Gravitational collapse of stars can be stopped and the pulsation rates of pulsars can be reproduced easily and a simple explanation for supernovae can be given. (auth)

27928 EVOLUTION OF RAPIDLY ROTATING STARS WITH MASS LOSS. Strittmatter, P. A. (Inst. of Theoretical Astronomy, Cambridge, Eng.); Robertson, J. W.; Faulkner, D. J. Astron. Astrophys.; 5: 426-30(May 1970).

A method is described for calculating evolutionary sequences of uniformly rotating stars, including the effects of equatorial mass loss. Results are presented for a 9-$M_\odot$ model with initial rotational velocity near maximum. The rate of mass loss during the hydrogen-burning phase is consistent with observational evidence from Be stars. (auth)

27929 A PHOTOMETRIC SEARCH FOR DISTANT OB STARS IN NORMA AND AN INVESTIGATION OF THE NORMA CLOUD. Schnur, G. (Landessternwarte, Heidelberg). Astron. Astrophys.; 5: 431-43(May 1970).

About 1500 stars in Norma were measured by means of photographic UBV photometry. With respect to the interpretation of the observations, frequency distributions in the (U−B, B−V) diagram were calculated for different models of interstellar absorption. In the Norma Cloud an increased density of A and F stars at a distance of 0.7 to 1.8 kpc, coinciding with the spiral arm−I, was found. No distant OB stars could be detected in the Norma Cloud. In a region near the galactic equator ($b^{II} = -1.0°$), numerous B stars were identified that belong to the spiral arm−I. (auth)

27930 A STUDY OF THE SHELL SPECTRUM 48 LIBRAE. Geuverink, H. G. (Astronomical Inst., Utrecht). Astron. Astrophys.; 5: 341-54(May 1970).

The main points of the observations in 1967 and 1968 are presented, and a comparison is made between the spectrum in 1957 and in 1967. A thorough study was made of the Hβ profiles in the years 1957, 1958, 1967, and 1968 and the component arising from the shell was separated from the stellar line. (W.D.M.)

27931 EVOLUTION OF A VIBRATIONALLY UNSTABLE 130-SOLAR-MASS MAIN-SEQUENCE STAR. Appenzeller, I. (Univ., Goettingen, Ger.). Astron. Astrophys.; 5: 355-71 (May 1970).

Nonlinear pulsation calculations were carried out for a 130 $M_\odot$ main-sequence star. For this purpose the dynamical equations of stellar structure were solved numerically, using an implicit difference method. The main results are: during the first 20,000 years (after the beginning of central hydrogen burning) the pulsation amplitude is too small to have any influence on the evolution of the star. After about 23,000 years, periodically recurring shock waves in the outer layers of the star result in the forming of an optically thick, continuously expanding shell around the star. Eventually the outermost layers of the shell reach the escape velocity and the star starts to lose mass at a maximum rate of about 4×10^{-5} $M_\odot$ per year. At this evolutionary stage the damping of the pulsations due to the loss of mechanical energy in the outer layers of the star becomes so large that the pulsation amplitude cannot increase any more. Thus, such a star is not destroyed rapidly by its vibrational instability (as suggested by earlier investigators), but a quasi-stationary state is reached, where the interior of the star is pulsating while the observable surface layers are expanding continuously. A comparison of the model calculations with the observed properties of the peculiar shell star P Cyg supports the hypothesis that P Cyg is a vibrationally unstable main-sequence star of $M > 100$ $M_\odot$. (auth)

27932 DETERMINATIONS OF THE RIGHT ASCENSIONS OF THE FUNDAMENTAL BRIGHT STARS IN THE DECLINATION RANGE FROM -90°A TO +40° WITH ZEISS TRANSIT INSTRUMENT NO. 18818. Loyola, P. R.; Shishkina, V. N. (Univ. Chile, Cerro Calan). Univ. Chile, Dep. Astron., Publ.; No. 4, 55-64(1968). (In Spanish).

A discussion is given of observations made at the National Astronomical Observatory of the University of Chile between April 1963 and September 1964 in order to determine the right ascensions of the bright fundamental stars in the declination range from −90° to +40°. The preliminary results obtained from the reduction of 41 series of observations show the existence of systematic errors in the fundamental system FK4 in the range from −60° to 90°. (IAA)

27933 SPECTROPHOTOMETRIC PARAMETERS OF EARLY-TYPE STARS. I. EQUIVALENT WIDTHS OF HYDROGEN LINES. Gutierrez-Moreno, A.; Moreno, H.; Stock, J. (Univ. Chile, Cerro Calan). Univ. Chile, Dep. Astron., Publ.; No. 4, 49-54(1968).

A determination was made of the equivalent widths of Hβ, Hγ, and Hδ for 232 stars. The observations were obtained with a photoelectric spectrum scanner attached to the 16-in. telescope of the Cerro Tololo Inter-American Observatory. The equipment makes it possible to record spectra down to nearly the sixth (photographic) magnitude. A table is presented which includes the number of the star in the Bright Stars Catalogue, the equivalent widths for Hβ, Hγ, and Hδ, the spectral type, and the number of scans used in the determination. (IAA)

27934 CONSIDERATIONS OF THE ANGULAR MOMENTA OF CLOSE BINARY SYSTEMS. Giannuzzi, M. A. (Osservatorio Astronomico, Rome). Osserv. Astron. Roma, Contrib. Sci.; No. 63, 151-66(1968). (In French).

Calculations of the angular momenta for 126 binary eclipsing systems are presented using Eggen's (1963) formula for visual binaries. The values obtained are grouped about the mean values of binary systems examined by Kopal (1956). The possible ways of evolution of different binary groups are discussed. It is suggested that under special conditions, the separated systems belonging to young spectral types can evolve in such a way that a contact may be created. (IAA)

27935 OSCILLATIONS AND THE STABILITY OF ROTATING MASSES WITH TOROIDAL MAGNETIC FIELDS. Nakagawa, Y.; Trehan, S. K. (High Altitude Observatory, Boulder, Colo.). Astrophys. J.; 160: 725-33(May 1970).

The oscillations and the stability of rotating masses for axisymmetric equilibrium configurations with toroidal magnetic fields are examined on the basis of the second-order virial equations. It is shown that the equilibrium state is, in general, not spherically symmetric except for the equipartition state with no surface rotation. It is also shown that the transverse shear modes and the toroidal modes of oscillation could become unstable for large values of surface rotation whereas these modes remain stable for the equipartition state. The pulsation mode which is coupled with the nonradial modes of oscillation is shown to become unstable either for large values of surface rotation or for strong magnetic fields. (auth)

27936 STELLAR EVOLUTION IN GLOBULAR CLUSTERS. Schwarzschild, Martin. Quart. J. Roy. Astron. Soc.; 11: 12-22 (Mar 1970).

The evolution of a typical globular-cluster star is shown in the Hertzsprung−Russell diagram. Two other basic results concern the age of the globular-cluster stars and their initial helium abundance. Thermal instabilities are considered, including a form not involving degeneracy. Three unsolved problems are outlined. (UK)

27937 ROCKET SPECTROSCOPY OF ZETA PUPPIS. Smith, Andrew M. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 160: 595-608(May 1970).

A spectrum of ζ Pup extending from 920 to 1360 Å with approximately 0.8 Å resolution has been recorded at rocket altitudes. Tentative identification of 102 multiplets of both stellar and interstellar origin has been made, from which it is concluded that all lines included in existing model atmospheres have been detected with the exception of those masked by telluric N_2 or strong P Cygni-type profiles. Additional weak absorption lines indicate a wide range of ionization and excitation entirely consistent with observations in the visible spectral region of stars of similar type; they also appear to affect sensibly the energy distribution within the spectrum. Transitions in C III (1176 Å), N III (900, 992 Å), N IV (955 Å), N V (1239, 1243 Å), O IV (1339, 1343 Å), O VI (1032, 1038 Å), and S VI (933, 944 Å) have been observed as P Cygni profiles. Except for the S VI lines, the mean radial velocities associated with ground-state transitions and the transition from the lowest triplet state in C III are close to an average velocity of 1770 km sec^{-1}; the mean radial velocities of the N IV and O IV ions are 530 and 150 km sec^{-1}, respectively. These results suggest a positive velocity gradient in the observed portion of the circumstellar envelope, and they also suggest that the escaping ions are loosely bound together with essentially no difference in their average acceleration away from the star. The inter-

stellar columnar density of atomic hydrogen was found to be $(7.6 \pm 2.5) \times 10^{19}$ cm^{-2}, the quoted uncertainty being due only to the uncertainty in establishing the continuum. The mean atom density becomes $(6.4 \pm 2.1) \times 10^{-2}$ cm^{-3} if an interstellar distance through atomic hydrogen of 390 pc is assumed. (auth)

27938 NEUTRAL HELIUM LINES AND THE HELIUM ANOMALY IN HOT STARS. Poland, Arthur L. (Indiana Univ., Bloomington). Astrophys. J.; 160: 609-17(May 1970).

Using previously calculated departures from LTE for He I in hot stars non-LTE and LTE line profiles and equivalent widths for the 2S-4P, 2P-4S, 2P-5S, and 2P-4D transitions in the singlet and triplet systems of neutral helium in model atmospheres of 20000 and 30000°K with log g = 4 were calculated. In comparing the LTE and non-LTE calculations it was found that: (1) the cores of the stronger lines were deepened by including non-LTE; (2) for some of the weaker lines non-LTE raises the core of the line; (3) the wings of the lines are formed in LTE, as are the forbidden components of the 2P-4D transitions; and (4) the equivalent widths of the lines are almost unaffected by non-LTE. Because the forbidden components of the 2P-4D transitions are formed in LTE and the allowed cores of these lines are strongly affected by non-LTE, a ratio was formed of line depth in the allowed component to line depth in the forbidden component to compare the non-LTE effect with observations. A comparison of LTE, non-LTE, and observed ratios shows that only the non-LTE results agree with the observations. Since the equivalent widths of the lines are not affected by non-LTE, LTE widths were calculated for a series of model atmospheres and it was found that the helium anomaly can be explained by LTE alone. In fact, the helium anomaly is basically a strong line/weak line effect. A comparison of the equivalent widths with observations indicates that the helium abundance in early-type dwarfs is about He/H = 0.12. (auth)

27939 ZIRCONIUM ISOTOPIC ABUNDANCES IN R CYGNI. Peery, Benjamin F. Jr.; Beeve, Reta F. (Indiana Univ., Bloomington). Astrophys. J.; 160: 619-25(May 1970).

Relative isotopic abundances of zirconium were found from the spectrum of the long-period-variable S star, R Cygni, by matching computed and observed profiles of the γ_2 0-0 band of $Zr^{16}O$. Fractional abundances are ^{90}Zr, 0.50; ^{91}Zr, 0.05; ^{92}Zr, 0.10; ^{93}Zr, 0.05; ^{94}Zr, 0.30; ^{96}Zr, 0.00, with uncertainties of the order of ±0.05. These results are close to the abundances to be expected from production of Zr by the s-process after extensive neutron exposure. Improved molecular constants of $^{90}Zr^{16}O$ were determined. (auth)

27940 MICROTURBULENCE IN A-TYPE SUPERGIANTS. Rosendhal, Jeffrey D. (Univ. of Washington, Seattle). Astrophys. J.; 160: 627-39(May 1970).

A survey was undertaken of microturbulence in high-luminosity stars. Details are given of an analysis of the small-scale velocity fields in ten A-type Ia supergiants. The results suggest that (1) in the A supergiants, the microturbulence initially decreases with increasing height in the atmosphere, reaches a maximum, and then increases again at small optical depths, and (2) time-dependent phenonema are important in the atmospheres of these stars. In addition, the combination of the present observations with published data indicates that in stars of luminosity class Ia, the microturbulence increases from middle B through late A, reaches its maximum somewhere in the spectral range F2-F5, and then decreases suddenly at about spectral type G0-G2. The behavior appears to be similar in the range A-M in the less luminous supergiants and bright giants. (auth)

27941 DIFFUSION PROCESSES IN PECULIAR A STARS. Michaud, Georges (Carnegie Institution of Washington, D. C.). Astrophys. J.; 160: 641-58(May 1970).

It is suggested that diffusion processes are responsible for most of the peculiar abundances observed in Ap stars. If it is assumed that the atmosphere is stable enough for diffusion processes to be important, gravitational settling leads to the underabundances of He, Ne, and O in the stars where they are observed (that is, with the θ_{eff}, log g they are observed to have). Radiation pressure leads to the overabundances of Mn, Sr, Y, Zr, and the rare earths in the stars where they are observed. Silicon would be expected to be overabundant only if it has wide autoionization features. Phosphorus would be expected to be overabundant in stars with $\theta_{eff} \simeq 0.5$, but is observed to be overabundant in stars with $\theta_{eff} \simeq 0.4$. The magnetic fields observed in Ap stars could bring to the atmosphere the stability needed for diffusion processes to be important. They would also guide diffusion into patches leading to the periodic variation of the observed overabundances. (auth)

27942 THERMAL-CONVECTIVE INSTABILITY. Defouw, Richard J. (Carnegie Institution of Washington, D. C.). Astrophys. J.; 160: 659-69(May 1970).

The Schwarzschild criterion for convection is generalized to include departures from adiabatic motion. It is demonstrated that a thermally unstable atmosphere is also convectively unstable, regardless of the atmospheric temperature gradient. If the latter is sufficiently subadiabatic (e.g., if the temperature increases rapidly with height), convection sets in as exponentially growing oscillations. In the presence of a magnetic field, a thermally unstable atmosphere is monotonically unstable, although overstability is also possible if the temperature gradient is subadiabatic. The effects of conduction, viscosity, opacity, and rotation are evaluated. The assumption is made that the radiative cooling (or the source function) depends only on the local values of density and temperature. (auth)

27943 THE EVOLUTION OF A RED GIANT AFTER RAPID MASS LOSS, AND THE HARMAN-SEATON SEQUENCE. Deinzer, Willi (Univ. of Colorado, Boulder); von Sengbusch, Kurt. Astrophys. J.; 160: 671-83(May 1970).

The evolution of a stellar model is investigated numerically in order to account for the consequences of mass loss preceding the observed evolution of the central stars of planetary nebulae. A red giant of 1.3 $M_\odot$ is stripped of almost all of its envelope, and hydrostatic equilibrium is restored by quasi-static, adiabatic expansion. The evolution of this model depends on the mass that remains in the envelope. If $\Delta M_{env}/M > 10^{-3}$, thermal equilibrium is restored, i.e., after the thermal-relaxation phase, the luminosity of the stellar model is produced entirely by the hydrogen-burning shell source. If $\Delta M_{env}/M \leq 10^{-3}$, thermal equilibrium cannot be restored, and after evolving through a luminosity maximum the model becomes a white dwarf. The evolutionary tracks obtained in the latter case are compared with the Harman-Seaton sequence. (auth)

27944 STRUCTURE OF CLOSE BINARY MEMBERS. Jackson, Stephen (Princeton Univ., N. J.). Astrophys. J.; 160: 685-99(May 1970).

A double-approximation method, similar to the one described by Roxburg, Griffith, and Sweet, is used to consider the effect of rotation and the tidal interaction upon the structure of a synchronously rotating binary component. For both the Cowling model and a similar electron-scattering model, this method is used to construct models for two distorted stars—one having a close companion of equal mass and the other being a rapidly rotating single star. The tidal force has almost no effect on the binary component's luminosity and is several times less effective than rotation in increasing the mean radius. Because the rotation is assumed to be synchronous, the binary component cannot rotate as fast as the single star. Consequently, the reduction in luminosity, which is due almost entirely to rotation, is correspondingly less than for the single star. Although for both stars the distortion is large near the surface, the double-approximation method gives very nearly the same luminosity as a first-order perturbation theory but is nevertheless required to treat the surface layers accurately. (auth)

27945 EFFECT OF AN ARBITRARY LAW OF SLOW ROTATION ON THE OSCILLATIONS AND THE STABILITY OF GASEOUS MASSES. Lebovitz, N. R. (Univ. of Chicago). Astrophys. J.; 160: 701-23(May 1970).

The operator formulation of stability theory is adapted to the case in which the rotation is slow (of order λ, say) and both the rotating configuration and the time-dependent disturbances are axisymmetric. It is shown that, to find the effect of rotation on the square of an oscillation frequency to first order in λ, one need only know the eigenfunction to order zero, i.e., one need only know the corresponding eigenfunction in the spherical case. The formulae obtained are applied to the case of radial pulsations and dynamical instability, where it is found that any law of rotation has a stabilizing influence, certainly if γ is constant, and probably in many cases when γ is variable. (auth)

27946 OBSERVATIONAL ASPECTS OF BLACK HOLES IN GLOBULAR CLUSTERS. Wyller, Arne A. (Franklin Inst., Swarthmore, Pa.). Astrophys. J.; 160: 443-9(May 1970).

Gravitationally collapsed cores (black holes) are postulated to exist as remnants of the initial formation process at the centers of globular clusters. It is shown that this hypothesis can be tested by spectroscopic observations and observations of gravitational radiation, although both types of tests strain the limits of present-day techniques. Differential line shifts from the stars in the vicinity of the black hole, primarily from effects of orbital velocity and secondarily from gravitational redshifts, should show up in the composite spectrum of the light center of the cluster. The rates

of gravitational radiation from a revolving pair of black holes at the center of the globular cluster will in certain cases exceed that of other suggested sources of gravitational radiation by up to five orders of magnitude, both in the Earth mode frequency (1 cycle/hour) and at higher frequencies such as low pulsar frequencies (1 c/s). (auth)

27947 THE INTERSTELLAR EXTINCTION OF STARS IN H II REGIONS. Anderson, Christopher M. (Carnegie Institution of Washington, D. C.). Astrophys. J.; 160: 507-17(May 1970).

Observations are presented which show that several stars involved in H II regions exhibit a color anomaly similar to that found for the Trapezium. Alternative explanations of the phenomenon are reviewed. (auth)

27948 HELIUM SPECTRUM AND DUST IN THE ORION NEBULA. Robbins, R. R. (Univ. of Texas, Austin). Astrophys. J.; 160: 519-30(May 1970).

Capture-cascade intensities appropriate to diffuse nebulae are calculated and then modified for self-absorption in the helium triplets by the construction and solution of an integral equation of transfer. Comparison between these calculations and observed helium intensities in the nebula show that N(He)/N(H) = 0.12 in Orion and that the optical thickness of the triplets is $\tau_0(3889) \approx 15$ if large-scale motions or expansion are not important in the transfer of radiation, but is closer to 25 if they are. The corresponding optical depths in the 10830 Å line would be 370 and 615. The fit between theory and observation is sensitive to possible inhomogeneities in optical depth in the nebula. The results from the transfer solution are found to be consistent with the population of the metastable 2^3S level that is implied by its equilibrium equation if the nebular material is assumed to exist in condensations occupying approximately one-twentieth to one-thirtieth of the volume of the nebula. It further agrees with the 2^3S population implied by the collisional excitation of λ10830 if account is taken of the destruction of these photons upon dust grains in the nebula. A significant fraction of the λ10830 photons appear to be extinguished on grains, which suggests in turn that hydrogen Lα is probably completely extinguished in this fashion. The dust opacity at λ10830 derived from the emergent intensity of λ10830 agree roughly with estimates from visual photometry and is relatively insensitive to assumed conditions. Under certain conditions, it should be a useful point for normalizing dust calculations. The above three methods of estimating the metastable population appear to be in fair agreement with the population implied by the λ3889 absorption features seen in the spectrum of the Trapezium stars, when the rate of magnetic-dipole depopulation for the 2^3S level recently calculated by Griem is employed. (auth)

27949 PHOTOMETRIC AND SPECTROSCOPIC OBSERVATIONS OF INFRARED STARS. Low, F. J. (Univ. of Arizona, Tucson); Johnson, H. JL.; Kleinmann, D. E.; Latham, A. S.; Geisel, S. L. Astrophys. J.; 160: 531-43(May 1970).

Photometric observations from U to Q (0.36 to 22 μ) are reported for six stars that are bright in the infrared: Becklin's Object, HD 45677, R Mon, T Tau, NML Cyg, and VY CMa. Spectroscopic observations from 2500 to 7000 cm^{-1} were obtained for three of these objects: NML Cyg, VY CMa, and HD 45677. These data suggest that all six systems contain protostars at various stages of evolution ranging in bolometric luminosity from 15 $L_\odot$ to 30000 $L_\odot$, although gravitational collapse appears to be an adequate source of energy. In every case, most of the infrared radiation appears to be produced by thermal reradiation from thin shells of circumstellar particles between 500 and 900°K. By using spectral data to determine the temperatures of the central stars, extinction curves were derived for two of these circumstellar shells. The resulting distribution of particle sizes is consistent with the long-wavelength behavior of the emission, which shows definite particle-size effects. By assuming spherical symmetry, the linear radii calculated for the shells range from 1.5 to 100 A.U.; the mass of dust was estimated to be 4 $M_\odot$ for VY CMa and 10^{-3} $M_\odot$ for T Tau, which are, respectively, the heaviest and the lightest of these objects. (auth)

27950 OH RADIO EMISSION ASSOCIATED WITH INFRARED STARS. Wilson, W. J. (Massachusetts Inst. of Tech., Cambridge); Barrett, A. H.; Moran, J. M. Astrophys. J.; 160: 545-71(May 1970).

A search of sixty infrared stars for OH emission at 1612 MHz was made. OH emission was detected from seven of these objects, and their spectra and polarization properties were measured. These OH sources are the first to be identified with stellar objects. Also, seven T Tauri and eight known red-giant stars were observed, with negative results. The OH source in NML Cygnus was studied with a very-long-baseline interferometer and found to be coincident in position with the infrared star within 5″ and to have individual spectral features within 2″ of one another with characteristic sizes of 0.08″. The characteristics of the OH emission are best explained by a partially saturated maser pumped by near-infrared radiation. A model of an evolved, very luminous red-giant star with an expanding atmosphere is proposed to explain the observed properties. (auth)

27951 EVIDENCE OF EXPANSION IN NGC 6888. Georgelin, Y. P.; Monnet, G. (CNRS, Marseille). Astrophys. Lett.; 5: 239-43(May 1970).

Interferometric Hα radial velocities in the shell nebula NGC 6888 show an expansion of 50 km sec^{-1} around the exciting Wolf-Rayet star. NGC 6888 is thus interpreted as coming from ejection of material from the central exciting star, and physical data on this process are given. (auth)

27952 RELATIVE ABUNDANCES OF MAGNESIUM ISOTOPES IN ARCTURUS. Bell, R. A. (Royal Greenwich Observatory, Herstmonceux, Eng.); Branch, David. Astrophys. Lett.; 5: 203-6 (May 1970).

Rotational lines of the $A^2\Pi - X^2\Sigma$ (0,0) band of MgH were used to determine the relative abundances of the magnesium isotopes in the atmosphere of Arcturus. It was found that $^{24}Mg : ^{25}Mg : ^{26}Mg = 80 : 10 : 10$, in agreement with the terrestrial and meteoritic ratios. (auth)

27953 ULTRA-SLOW NOVAE. Glebocki, Robert. Postepy Astron.; 18: 59-80(Jan-Mar 1970). (In Polish).

A general description of photometric, spectral, and kinematic characteristics of ultraslow novae, called also RT Ser-type novae, is given. All suspected members of this group are described and suggestion is made that Nova Delphini 1967 is also of RT Ser type. It is pointed out that distribution of ultraslow novae in the Galaxy shows population II characteristics. (auth)

27954 BIBLIOGRAPHY OF COLOR-MAGNITUDE DIAGRAMS FOR GLOBULAR CLUSTERS. White, Ramond E. (Univ. of Arizona, Tucson). Astrophys. J., Suppl. Ser.; 19: No. 177, 343-66(Apr 1970).

A bibliography of all the published color-magnitude diagrams for the galactic globular clusters is presented in tabular form. Certain C-M diagrams are reproduced. (auth)

27955 IDENTIFICATION OF INFRARED CN BANDS IN THE SPECTRA OF SEVERAL CARBON STARS. Thompson, Rodger I.; Schnopper, Herbert W. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 160: L97-100(May 1970).

Identification of the 2-4 and 3-5 bands of the CN red system is made for W Ori, 19 Psc, U Hya, and X Cnc. These bands occur in the infrared spectra region between 2 and 2.5 μ. A possible identification has been made of the $\Delta v = -1$ bands in the (1.8 to 1.4)-μ region. This identification is consistent with the expected high concentration of the CN molecule in the atmospheres of carbon stars. (auth)

27956 ANALYSIS OF THE STAR 15 VULPECULAE SHOWING METALLIC LINES, BY THE DIFFERENTIAL METHOD OF THE STELLAR CURVES OF GROWTH. Faraggiana, Rosanna; Van't Veer-Menneret, Claude (Centre National de la Recherche Scientifique, Paris). Compt. Rend., Ser. B; 270: 765-8(16 Mar 1970). (In French).

Preliminary results obtained by the curves-of-growth method show a normal abundance of calcium and iron, but a small excess of metals heavier than iron. (France)

27957 ASTROPHYSICAL PROBLEMS. Tombrello, T. A. (California Inst. of Tech., Pasadena). pp 195-212 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

The proton-proton chain for determining the stellar reaction rates is discussed. Topics considered include $^1H(p,\beta^+\nu)^2H$, $^2H(p,\gamma)^3He$, $^3He(^3He,2p)^4He$, $^3He(\alpha,\gamma)^7Be$, $^7Be(p,\gamma)^8B$, and the p-p chain and neutrino astronomy. (W.D.M.)

27958 ON THE NATURE OF THE UNDERLYING STAR ASSOCIATED WITH SCO X-1. Felman, P. A.; Gribbin, J. R.; Plagemann, S. H. (Univ. of Cambridge, Eng.). Nature (London); 226: 432-4(2 May 1970).

Evidence was reported for the existence of short-term periodic variations in the optical "flickering" of Sco X-1 following a large optical flare on the night of April 3, 1967 (Gribbin et al., Nature 225: 1123(1970)). It is believed that the pronounced feature observed at ~0.006 Hz in the power spectrum of the immediate post-flare data can be explained in terms of acoustic oscillations of a hot bounded plasma atmosphere in the strong gravitational field of a dense underlying star, and there is evidence that this star

must be either a white dwarf or a neutron star. The size of the peak in the post-flare power spectrum led to the belief that if this feature represents a fundamental acoustic mode, then harmonics of this vibration might also be detected, and a simple theoretical model was adopted for the hot plasma atmosphere of Sco X-1 in order to calculate the expected harmonic modes, involving a compressible isothermal, fully ionized hydrogen gas in a uniform "vertical" gravitational field, and "effective" boundary conditions that consist of a fixed base and free boundary at the top of the atmosphere. The harmonic mode that is most likely to be excited is the first, and analysis showed that the broad feature at ~0.006 Hz could be resolved into two components, a large peak at 0.0055 Hz and a smaller peak at 0.0085 Hz, representing respectively the fundamental and the first harmonic modes. Estimates were made of the effective values of the gravitational acceleration and the atmospheric thickness, and the very high value formed for g in the thermally radiating atmosphere of Sco X-1 must imply that the underlying star is a condensed object. The findings would seem to confirm the belief that star-like galactic x-ray sources are probably associated with condensed stellar objects. (UK)

Quasi-Stellar, Radio, and X-Ray Sources

27959 (CSIRO-Trans-9722) FORMULAE, GRAPHS, AND TABLES FOR A QUANTITATIVE ANALYSIS OF THE HYDROGEN RADIATION OF EMISSION OBJECTS. Boyarchuk, A. A.; Gershberg, R. E.; Godovnikov, N. V. Translated by A. K. Rothfield (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia), from Izv. Krym. Astrofiz. Observ.; 38: 208-18(1967). 14p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 23: 6826.

27960 (TID-3320) PULSARS. Bibliography. Matheny, William D. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). May 1970. 53p. Dep. CFSTI.

This bibliography contains 442 abstracts of literature going back to 1957 from Nuclear Science Abstracts. NSA Vol. 24, number 6 was the cutoff for the current literature. (W.D.M.)

27961 REDSHIFT AND THE SIZE OF DOUBLE RADIO SOURCES. Legg, T. H. (National Research Council, Ottawa). Nature (London); 226: 65-7(4 Apr 1970).

A relationship between redshift and the angular size of radio sources has been sought with limited success, but it is stated that it now seems possible to establish a more definite relationship using published data. A study is described of 32 radio galaxies and 25 quasars predominately double in structure, and data are listed that are believed to include most of the currently known sources having a measured redshift and two well-defined components. A number of sources with more complex structure are included and, for these, the dimension considered is the separation between the outermost emission peaks. The angular separation of the source components against redshift is shown plotted, and fits of world models to the curves are discussed. Cosmological evolution may be affecting the maximum size of the sources. The most significant feature of the data is that the quasars fit smoothly into a redshift-size relationship with the ordinary radio galaxies, offering considerable support to the cosmological interpretation of redshift. The distribution of linear separations of the sources shows several interesting features and histograms are shown. In each histogram there tends to be a comparatively large number of small sources, but few of intermediate size. Since the Einstein-de Sitter model fits the curves reasonably well, at least for the larger sources, it can be inferred that the distribution of true linear separation is approximately uniform from, say, 80 to 320 kpc for the radio galaxies and from 140 to 230 kpc for the quasars. The range of separation in which there are few sources extends from about 40 to 80 kpc for the radio galaxies and from about 60 to 140 kpc for the quasars. The lack of sources may be due to adiabatic expansion and fading of the components when they reach the lower intergalactic density. (UK)

27962 OBSERVED SHAPES OF CRAB NEBULA RADIO PULSES. Stallin, D. H. (Massachusetts Inst. of Tech., Cambridge); Sutton, J. M. Nature (London); 226: 69-70(4 Apr 1970).

Pulses are known to exhibit irregularities, on time scales of 0.1 to 10 msec, which include sub-millisecond bursts, reaching subpulses and polarisation variations, and a search is described for such irregularities in signals from the Crab Nebula pulsar NP 0532. Observations were made with the 300 ft transit telescope at the National Radio Astronomy Observatory, Green Bank, West Virginia, for 70 min each day, using a system having a signal-to-noise ratio six times the usual value. A series of spectra at intervals of ~55 ms from one isolated pulse is shown for frequencies of 118 and 157.5 MHz. The pulse shapes at both frequencies were unresolved; the decay time constants, however, were substantially different. The possibility cannot be excluded that there is an impulse at the origin with energy less than approximately half the total pulse energy. Secondary pulses and following primary pulses were occasionally evident, and usually much smaller than the leading pulse, and there was a definite tendency for strong primary pulses at 157.5 MHz to be accompanied by secondaries about 0.05 times as strong. There is a possibility that what were assumed to be strong primary pulses were actually secondary pulses. A tendency to generate strong pulses singly and only at intervals of hundreds or thousands of pulses was another unusual property of NP 0532. The substantial difference in decay time between the closely spaced frequencies 118 and 157.5 MHz indicates that the spectral index of the emission is time-dependent and becomes very steep a few time constants after commencement of the pulse; this may imply the presence of variable absorption or emission resonances at the pulsar. Such spectra can also arise if different particle populations are responsible for the radiation observed at different frequencies. Observations with circular and linear polarisation did not show any frequency or polarisation fine structure other than occasional weak spectral features with widths of the order of 1 MHz. (UK)

27963 LINEAR POLARISATION OF DISTANT QUASARS. Conway, R. G.; Gilbert, J. A. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London); 226: 332-3(25 Apr 1970).

Measurements of the linear polarisation of quasars at a wavelength of 49 cm (m_{49}) showed that this parameter is correlated with spectral index (α). In the studies described, using a sample of 93 quasars of measured redshifts, this correlation was confirmed, and a further correlation was detected between m_{49} and redshift (z). The relation between m_{49} and z is shown graphically both for flat and steep spectrum quasars; the median value of m_{49} falls markedly as z increases for flat-spectrum quasars, but is almost independent of z for steep-spectrum quasars. The separation between flat- and steep-spectrum quasars is especially marked for low redshifts. This separation does not exist for polarisation measured at shorter wavelengths, and is therefore a depolarisation effect, presumably by Faraday rotation within the source. Both the observed trends are at variance with what would be expected on simple arguments; since, an average, sources show an increase of polarisation with decreasing wavelength, an increase in median m_{49} with z would be expected, and this applies whether or not the redshift is cosmological in nature. The depolarisation effect is unlikely to be due to dilution by unpolarised components with abnormal spectra. It might be produced by Faraday rotation in randomly distributed objects, but only if their size or space density beyond $z = 1$ exceeds the local value for galaxies. Whether the intervening objects are randomly distributed or are physically associated with the sources, they should show other absorption effects. It is believed that the depolarisation is due to Faraday rotation in the same regions as responsible for the absorption lines. Information obtained from the Faraday rotation should be of great importance in helping to define the nature of the objects responsible for the absorption lines. (UK)

27964 UPPER LIMIT ON THE INTENSITY OF Sgr γ-1 IN SOFT X RAYS. Naranan, S. (Tata Inst. of Fundamental Research, Bombay). Nature (London); 226: 333(25 Apr 1970).

Evidence has been reported for a point source of γ rays (Sgr γ-1), with an intensity of $(3 \pm 1) \times 10^{-5}$ photons/cm^2/s (>50 MeV). Assuming that the source is real, an upper limit can be set on its soft x-ray intensity (1.5 to 6 keV) from an Aerobee rocket experiment flown on July 7, 1967; this was found to be 0.4 counts/cm^2/s or <0.80 photons/cm^2/s. Corresponding data for the Crab Nebula are $\gamma = <1.7 \times 10^{-5}$ and x ray = 4.5 photons/cm^2/s. Limits were also estimated for the spectral index (2), assuming both sources have a power law photon number spectrum $E^{-\alpha}$ dE from x-ray to γ-ray energies. For the Crab Nebula the energy spectrum can be expressed as $7\ E^{-2}$ in the energy range 1 to 500 keV, followed by a steepening at higher energies. Assuming that Sgr γ-1 is a discrete γ-ray source it thus has an intensity ~1/3 of the Crab Nebula for soft x rays of 1.5 to 6 keV; below 50 MeV it has a spectrum flatter than that of the Crab Nebula. (UK)

27965 QUASARS BEHIND CLUSTERS OF GALAXIES. Barnothy, J. M.; Barnothy, M. F. (Univ. of Illinois, Chicago). Nature (London); 226: 335-7(25 Apr 1970).

It is stated that 21 QSOs with redshifts >Z = 0.2 have been found in the direction of Zwicky clusters, and in all of these the redshifts of the QSOs are considerably larger than the redshifts of the associated clusters. Assuming that the redshifts are cosmological these quasars would be at considerable distances behind the clusters. This suggests the simple explanation of the association of clusters with QSOs that the latter are gravitational lens images produced by a cluster member (small, compact, dwarf, or dead galaxy) acting as the lens on an object (Seyfort galaxy) situ-

ated at the cosmological distance corresponding to the redshift of the QSO. It is noted that a gravitational lens does not have a real focal length and produces two images, and such an effect was applied to explain pulsating radio sources. Every galaxy is a potential gravitational lens for all objects appropriately lined up behind it, and the presence of a large number of gravitational lens images over the sky is evident. It is generally assumed that at least 50% of galaxies are members of clusters of galaxies, and consequently, if QSOs are gravitational lens images with 50% of the lenses being cluster galaxies, it would be expected that 80 out of the 160 or so known QSOs would be seen behind a cluster. The case of 3C 273 is discussed as being an interesting case of the connection of a QSO with a cluster; its brightness variation pattern is to be expected if it is a gravitational lens image and the optical axis of the lens scans the nucleus of a Seyfert galaxy which itself consists of a large number of discrete secondary light sources. As 3C 273 is in the direction of the Virgo cluster, which is at a distance of 11.4 MpC, this suggests that the lens is a compact galaxy of type Zw 0930-5527 or 1117-5141 in the Virgo cluster. The chance that one of the galaxies belonging to a cluster of galaxies would act as a lens for a remote nucleus of a Seyfort galaxy is estimated, and the chance of finding an image with the properties of a QSO behind an average cluster containing about 130 galaxies is found to be 1 in 400. The presence of dead invisible galaxies in intergalactic space might increase this value by a factor of 25 to 50, however. (UK)

27966 SHAPE OF THE CRAB PULSAR AND ITS PERIOD FLUCTUATIONS. Chiuderi, C.; Occhionero, F. (Goddard Space Flight Center, New York). Nature (London); 226: 337-8(25 Apr 1970).

Sinusoidal variations in the arrival times of radio pulses from NP 0532, with a period of about 3 months and an amplitude of 6×10^{-4} S, have recently been recorded, and this effect can be interpreted in terms of genuine sinusoidal variations of the circular frequency of this pulsar. The corresponding equation can be explained by the widely accepted oblique rotator model by investigating an interesting consequence of the possible ellipticity of the neutron star. In order to account for the history and energy balance of the Crab Nebula an upper limit must be placed on this ellipticity, such that the gravitational quadrupole radiation dominates the magnetic dipole radiation only in the early life of the pulsar. It turns out that the explanation given for the anomalies in the pulse arrival times provides an even stranger limit to the deviations from spherical symmetry allowed in a neutron star. The model assumed for NP 0532 is a slightly aspherical ellipsoid, and the pulsar behaves as a "free top." The motivation adopted for the lack of axial symmetry is magnetic and not rotational. Application of the oblique rotator model is discussed in detail. It is pointed out that although the rotational deformations of a general relativistic neutron star have been evaluated under the assumption of axial symmetry, such computations are forbiddingly difficult for an ellipsoid. If the explanation given for the period fluctuations is correct, the existence of strong forces in a neutron star forbidding relatively wide deformations is indicated; a very thick solid crust might perhaps be adequate. The observed phenomena appear to emphasize the precision of the pulsar clock and support the notion of a beacon on the neutron star surface rather than farther out. (UK)

27967 POSSIBILITY OF THE ORIGIN OF DISCRETE-SOURCE RADIO SPECTRA WITH A POSITIVE CURVATURE. Sazonov, V. N. (Lebedev Inst. of Physics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 13: 214-18(1970). (In Russian).

Possible mechanisms of the origin of radio spectra are considered, for which the radiation fluxes are increased more rapidly with decreasing of the frequency than follows from the power law. (auth)

27968 REDISCUSSION OF THE RADIO SPECTRUM OF THE ORION NEBULA. Shaver, P. A.; Mills, B. Y. (Univ. of Sydney). Proc. Astron. Soc. Aust.; 1: 217-8(Mar 1969).

The radio continuum spectrum of the Orion Nebula has been the subject of some misconception, particularly at low frequencies. A rediscussion was thought to be worthwhile as the spectrum has been used to derive an electron temperature for the nebula which is at variance with other determinations and carries important implications. Also, some of the difficulties of measurement and problems of interpretation are relevant to similar investigations of other emission nebulae. (W.D.M.)

27969 SEARCH FOR AN INTERGALACTIC CLOUD IN MICROSCOPIUM AT 21 CM. Poeppel, W. G. L. (Instituto Argentino de Radioastronomia, Buenos Aires). Astron. Astrophys.; 5: 400-6(May 1970).

A region in Microscopium, which includes Hoffmeister's proposed intergalactic cloud, was observed in 21 cm. The only hydrogen radiation detected has very low velocity and does not show any correlation with the cloud sketched by Hoffmeister. An upper limit for the total atomic hydrogen mass of the cloud was derived. It is lower than the total masses used tentatively by Schmidt. (auth)

27970 A RECOMBINATION LINE OF MAPPING THE H II REGION W3 (IC 1795). Rubin, R. H.; Mezger, P. G. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. Astrophys.; 5: 407-12(May 1970).

The H109α recombination-line emission from the H II region W3 (IC 1795) was observed in a grid of 43 points separated by 3' (approximately one-half the half-power beamwidth of the telescope). The observed quantities are displayed as contour maps. (auth)

27971 OBSERVATIONS OF INTERSTELLAR FORMALDEHYDE. Zuckerman, B. (Univ. of Maryland, College Park); Buhl, David; Palmer, Patrick; Snyder, Lewis E. Astrophys. J.; 160: 485-506(May 1970).

The 140-foot telescope of the National Radio Astronomy Observatory was used to make extensive observations of the $1_{11} \rightarrow 1_{10}$ rotational transition of interstellar formaldehyde. This 4830-MHz transition was detected in absorption in the direction of approximately half of the forty-three galactic or extragalactic objects examined. (These "objects" were not all 6-cm continuum radio sources.) 4830-MHz emission, as well as the H_2CO transitions $6_{25} \rightarrow 6_{24}$, $13_{3\,11} \rightarrow 13_{3\,10}$, $21_{4\,18} \rightarrow 21_{4\,17}$, was also searched for but not detected. Circular and linear polarizations of some features were sought, but neither was detected. H_2CO radial velocities were compared with those of other atomic and molecular constituents of the interstellar medium. The H_2CO velocities often correspond to OH and H I absorption features. In such cases the H_2CO generally appears to be more localized than the H I. The astronomically determined H_2CO rest frequency is in excellent agreement (~1 kHz) with the laboratory value. Projected densities of observed H_2CO features lie between 10^{12} and 10^{13} cm^{-2} for an assumed excitation temperature of 3°K. With this assumption and the assumption that the H_2CO uniformly covers the continuum source, the ratio of H_2CO to H I projected density is typically 10^{-9}. (auth)

27972 INTERPLANETARY SCINTILLATIONS AND THE STRUCTURE OF SOLAR-WIND FLUCTUATIONS. Jokipii, J. R.; Hollweg, Joseph V. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Astrophys. J.; 160: 745-53(May 1970).

It is demonstrated that the observed correlation scale of the interplanetary scintillation of radio sources is consistent with a plasma-density correlation length of 10^6 km or more. This result is in sharp contrast to previous analyses which inferred a correlation length of 100 to 200 km. Fluctuations in plasma density may therefore have a structure similar to that observed for the interplanetary magnetic field and plasma velocity. It was found that in this case of a long correlation length the rms phase fluctuation produced in the radio wave by the solar plasma is very large (~10^4 radians) and that the 100 to 200-km scale inferred in previous work is then closely related to the "inner scale" of the fluctuations, i.e., that wavelength below which there is little power. (auth)

27973 SEARCH FOR INTERSTELLAR NO AT RADIO FREQUENCIES. Turner, B. E. (National Radio Astronomy Observatory, Green Bank, W. Va.); Heiles, C. E.; Scharlemann, E. Astrophys. Lett.; 5: 197-201(May 1970).

A search has been conducted for interstellar NO radio lines, at approximately 431, 411, 226, and 206 MHz at the Arecibo Observatory and at the National Radio Astronomy Observatory. No definite detection has been made in 67 galactic sources covered. The observations were carried out at frequencies calculated on the basis of existing laboratory data. Measured frequencies which later became available were within the search band which was centered on the calculated frequencies. Conclusions are drawn on the negative results of the search and on the accuracy of the frequency calculation. (auth)

27974 PROGRESSIVE DEFORMATION OF THE CRUST OF PULSARS. Smoluchowski, R.; Welch, D. O. (Princeton Univ., N. J.). Phys. Rev. Lett.; 24: 1191-2(25 May 1970).

It is shown that the crust of pulsars can deform in a gradual plastic manner in spite of its extreme density and strength. This deformation leads to stronger damping of pulsar rotation and to higher magnetic moments and also to rarer starquakes than calculated for a rigid crust. (auth)

27975 PENCIL-BEAM OBSERVATIONS OF FORNAX A, VIRGO A, AND CENTAURUS A AT 408 MHz. Cameron, M. J.

(Univ. of Sydney). Proc. Astron. Soc. Aust.; 1: 229-31(Mar 1969).

Radio contours are presented for Fornax A, Virgo A, and the central component of Centaurus A. The work forms part of a survey of all bright galaxies with the Molonglo cross down to a corrected total magnitude of 11.0 m with an extension down to photographic magnitude 12.5m in a limited region of the sky. (W.D.M.)

27976 OBSERVATIONS OF DOUBLE SOURCES RESOLVED AT 408 MHz. Schilizzi, R. T.; McAdam, W. B. (Univ. of Sydney). Proc. Astron. Soc. Aust.; 1: 228-9(Mar 1969).

In a study of radio sources in the southern sky, observations were made of 190 sources noted as "extended," "possibly extended," or "confused" in the Parkes and other catalogs. Those sources with structure resolved by the Molonglo cross telescope were selected for further analysis. The parameters found for an initial group of 32 double sources that have resolved components are discussed. (W.D.M.)

27977 DETERMINATION OF HELIUM ABUNDANCE FROM RADIO RECOMBINATION LINES. Churchwell, E.; Mezger, P. G. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Lett.; 5: 227-31(May 1970).

New observational evidence is presented that (i) the relative abundance of singly ionized helium, as determined from radio recombination lines, is not affected by possible non-LTE effects; and that (ii) the ionization state of helium changes — if at all — only slowly with position in M17 and M42. The agreement of radio determinations with recent optical determinations of helium abundances in M8, M17, and M42 is shown to be very good. (auth)

27978 APERTURE SYNTHESIS OBSERVATIONS OF ORION A AT 2,695 GHz. Webster, William J. Jr. (Case Western Reserve Univ., Cleveland); Altenhoff, Wilhelm J. Astrophys. Lett.; 5: 233-8(May 1970).

The radio source Orion A was mapped with the 2.7-km interferometer of the National Radio Astronomy Observatory. With the synthesized half-power beamwidth of 7 by 35 arc sec, a considerable amount of structure was detected. In addition to a broad component apparently associated with the structure detected in single antenna observations, smaller components apparently associated with each of the O stars in the θ Orionis complex were detected. The small structures can be interpreted as the remnants of the protostar cloud complex from which the stars of the Orion Nebula formed. (auth)

27979 PHYSICS OF ROTATING MAGNETIC NEUTRON STARS. Goldreich, P. (Univ. of Sydney). Proc. Astron. Soc. Aust.; 1: 227-8(Mar 1969).

The main conclusions from a study of the simplest model of a pulsar, regarded as a neutron star with an external dipole field aligned with the rotation axis, are: (1) despite its intense surface gravitational field, a rotating magnetic neutron star must have a dense co-rotating magnetosphere and (2) charged particles are accelerated along polar field lines and escape to infinity. Such an axisymmetric model cannot account for the periodic radiation from pulsars. The consequences of assuming that the pulsars are nonaxisymmetric versions of this model are outlined. (Australia)

27980 PULSAR AMPLITUDE VARIATIONS. Wielebinski, R. (Univ. of Sydney). Proc. Astron. Soc. Aust.; 1: 226-7(Mar 1969).

Pulsars display a complicated pattern of amplitude variations. The scale of variations range from months through hours to subMilliseconds. Polarization data for CP 1919 and intensity distribution data for PSR 0833-45 are presented that are relevant to pulse-to-pulse variations and the variations over periods of hours, respectively. (W.D.M.)

27981 COMPARISON OF PULSE SHAPES OF PULSARS AT DIFFERENT FREQUENCIES. McCulloch, P. M. (Univ. of Tasmania, Hobart, Australia); Hamilton, P. A.; Komesaroff, M. M.; Cooke, D. J. Proc. Astron. Soc. Aust.; 1: 225-6(Mar 1969).

Observations at a number of frequencies indicate that for at least two pulsars the average pulse shape has a slow but quiet definite frequency dependence. Average pulse shapes are shown for CP 1919, CP 0950, and CP 1133. (W.D.M.)

27982 PULSAR OBSERVATIONS AT MOLONGLO. Vaughan, A. E.; Large, M. I. (Univ. of Sydney). Proc. Astron. Soc. Aust.; 1: 220-3(Mar 1969).

Parameters of a recently discovered pulsar, MP 0628, are given. A schematic diagram is given of the Molonglo Radio Telescope showing some of the beams that are available. Fan-beam observations of ten pulsars are illustrated. (W.D.M.)

27983 STUDIES OF H_2O SOURCES BY MEANS OF A VERY-LONG-BASELINE INTERFEROMETER. Burke, B. F. (Massachusetts Inst. of Tech., Cambridge); Papa, D. C.; Papadopoulos, G. D.; Schwartz, P. R.; Knowles, S. H.; Sullivan, W. T.; Meeks, M. L.; Moran, J. M. Astrophys. J.; 160: L63-8(May 1970).

Observations of the H_2O sources associated with the objects W3 (OH position), Orion Nebula, W49, and VY Canis Majoris with coherent interferometers of baseline lengths 1.7×10^7 and 5.0×10^7 wavelengths were made. None of the sources have been resolved at the limit of the resolution of about 0.003'' of arc. The angular separation of two features in W49 is found to be 0.7''. (auth)

27984 ON THE INITIAL EXCITATION TEMPERATURE OF INTERSTELLAR H_2CO MOLECULES. Oka, T. (National Research Council of Canada, Ottawa). Astrophys. J.; 160: L69-71(May 1970).

The excitation temperature determined from the lowest K-type doubling line of the interstellar H_2CO molecules is discussed. It is shown that, because of the rigorous dipole selection rules, the molecules are "adiabatically cooled" as they make transitions to lower levels by spontaneous emission. If a Boltzmannian rotational distribution is assumed at the time of formation, the initial excitation temperature is given by $kT_e = 2hB$, regardless of the temperature of formation. (auth)

27985 POLARIZED-BRIGHTNESS DISTRIBUTION FOR 3C 20. Fomalont, E. B. (California Inst. of Tech., Pasadena). Astrophys. J.; 160: L73-7(May 1970).

High-resolution maps at 2695 MHz using the NRAO three-element interferometer were obtained for the linearly polarized and total radiation of 3C20. The synthesized beam width for the maps is about 6'' in diameter. The total radiation shows a common structure composed of two unresolved components with larger-scale radiation between them. The polarized distribution shows good correspondence with the total distribution. The intense components are only slightly polarized whereas the central regions have polarizations as large as 20%. (auth)

27986 SPECTROGRAPHIC OBSERVATIONS OF SIX RADIO SOURCES. Demoulin, Marie-Helene (Institut d'astrophysique, Paris). Astrophys. J.; 160: L79-81(May 1970).

From spectrographic observations, (1) the central density and the mass within 1 kpc of the elliptical galaxy NGC 3998 (10^{-21} g cm^{-3} and 7.4×10^9 $M_\odot$, respectively) and (2) the redshifts of four radio galaxies were obtained. (auth)

27987 SEARCH FOR REDSHIFTED 21-CM ABSORPTION IN QUASI-STELLAR OBJECTS. Heiles, Carl (Arecibo Observatory, Puerto Rico); Miley, George K. Astrophys. J.; 160: L83-6(May 1970).

The QSOs 3C 191 and PKS 1116 + 12 were investigated for redshifted neutral-hydrogen absorption. In no case was any absorption line detected, a fact providing further evidence that the optical absorption does not arise from interstellar matter in intervening galaxies. (auth)

27988 RAPIDLY ROTATING SUPERMASSIVE STARS. Fahlman, G. G. (Univ. of Toronto). Astrophys. J.; 160: L87-90 (May 1970).

The recent suggestion that the high energy needed for the activity of quasi-stellar objects is derived from the kinetic energy of rotating supermassive stars is examined. On the basis of this study, it is concluded that objects like 3C 345 and 3C 454.3 cannot be uniformly rotating supermassive stars. (auth)

27989 RUNAWAY STARS AND THE PULSARS NEAR THE CRAB NEBULA. Gott III, J. Richard (Princeton Univ. Observatory, N. J.); Gunn, James E.; Ostriker, Jeremiah P. Astrophys. J.; 160: L91-5(May 1970).

The "runaway stars" formed when one member of a binary system explodes will be followed by the runaway remnants of the exploded stars; thus many pulsars should be high-velocity (~100 km sec^{-1}) objects. Treating the pulsars 0527 and 0531 as the remnants of a binary system which was originally in the association I Gem, the proper motion and rate of period change for 0527 are predicted. Proper-motion observations will enable a check to be made of the runaway-remnant hypothesis; observations of P_z will check this hypothesis and provide a constraint on pulsar theories. (auth)

27990 DISCRETE ABSORPTION AND PHOTODISSOCIATION OF MOLECULAR HYDROGEN. Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass.); Stephens, T. L. Astrophys. J.; 160: L107-9(May 1970).

Accurate calculations are reported of the radiative lifetimes of the different vibrational levels of the excited $B^1\Sigma_u^+$ and $C^1\Pi_u$ states of molecular hydrogen and of the fractions of the absorptions that

terminate in the vibrational continuum of the ground electronic state leading to dissociation. For a uniform radiation field with a cutoff at the Lyman limit, the fraction is 22.9% for absorption into the $B^1\Sigma_u^+$ state and 8.0×10^{-5} percent for absorption into the $C^1\Pi_u$ state. (auth)

27991 PULSAR NP 0532. PROPERTIES AND SYSTEMATIC POLARIZATION OF INDIVIDUAL STRONG PULSES AT 430 MHz. Heiles, Carl (Arecibo Observatory, Puerto Rico); Campbell, D. B.; Rankin, J. M. Nature (London); 226: 529-31(9 May 1970).

Further detailed measurements of strong radio pulses from NP 0532 in the Crab Nebula recorded at Arecibo are described and compared with those reported by Graham, et al., (Nature 225: 526(7 Feb. 1970)). The presence of circular polarization was found, in conflict with previously reported predominantly linear polarization. This might be due to the use of 8.2-kHz bandwidth as against 330 kHz. It is suggested that observing with large bandwidths averaged over the width of the main pulse might obliterate any circular polarization or that due to the larger bandwidth. Large precursors were observed that most likely would have different polarization properties. (UK)

27992 THE UNUSUALLY LARGE REDSHIFT OF 4C 05.34. Lynds, R. (Kitt Peak National Observatory, Tucson, Ariz.); Wills, D. Nature (London); 226: 532(9 May 1970).

The quasi-stellar object identified with the radio source 4C 05.34 was observed spectroscopically and was found to have a redshift of z = 2.877, a value considerably higher than that of any quasi-stellar object reported so far. Because of the large redshift, the intrinsic luminosity of 4C 05.34 is very dependent on the particular cosmology that is adopted. With this reservation, the radio and optical luminosities appear to be roughly comparable with the most luminous quasi-stellar objects already known. It is suggested that the low rate of discovery of objects with redshifts in the range 2.4 to 3.0 is largely a consequence of their intrinsic rarity. (UK)

27993 UPPER LIMITS FOR CP 1919 X-RAY EMISSION. Gruber, Duane; Matteson, James L.; Pelling, Michael R.; Peterson, Laurence E. (Univ. of California, San Diego). Nature (London); 226: 532-4(9 May 1970).

A search is reported in the direction of the pulsar CP 1919 that resulted in upper limits on possible x-ray emission from this object at 3.9×10^{-33} J m^{-1} Hz^{-1} per pulse over the 30 to 100-keV range. The data were obtained from a balloon flight at 3.5 g cm^{-2} atmospheric depth. (auth) (UK)

27994 POSSIBLE PULSED GAMMA-RAY EMISSION ABOVE 50 MeV FROM THE CRAB PULSAR. Vasseur, J. (CEN, Saclay, France); Paul, J.; Parlier, B.; (and others). Nature (London); 226: 534(9 May 1970).

A search for pulsed gamma-ray emission from NP 0532 was carried out with a balloon-borne experiment using a spark chamber sensitive to gamma rays above 50 MeV as the central detector. This pulsar, situated in the Crab Nebula, was already known to pulsate in the radio, optical, and x-ray range. A rough estimate of the observed pulsed flux is of the order of 10^{-5} photons cm^{-2} s^{-1}, not inconsistent with the upper limits of the total flux. The pulsed fraction of the gamma-ray emission in this energy range seems to be very high, as is the pulsed fraction in the upper energy side of the x-ray range. (auth) (UK)

27995 OBSERVATIONS OF PP 0943. Zeissig, G. A. (Arecibo Observatory, Puerto Rico). Nature (London); 226: 536(9 May 1970).

Measurements were made on the pulsar PP 0943 using a 300-m-diameter radio telescope at radio frequencies of 73.8, 111.5, 196.5, 318.0, and 606.0 MHz. The values of the basic parameters of this pulsar were measured as: R.A.(1950.0), 09h 43m 19.6 ± 20s; dec.(1950.0), 10°05′ 33 ± 5″; dispersion measure, 15.35 ± 0.01 cm^{-3} pc; period, 1.097707 ± 0.000003 sec; galactic longitude, 225.4°; galactic latitude, 43.1°; average peak flux at 111.5 MHz, approximately 2 flux units. (auth) (UK)

27996 SPECTRAL INDEX–FLUX DENSITY RELATION FOR QUASARS. Dagkesamauskii, R. D. (Lebedev Inst. of Physics, Moscow). Nature (London); 226: 432(2 May 1970).

The relation between the mean spectral indices (d) of extragalactic radio sources and their flux densities at 178 MHz was estimated from available data on the flux densities of all radio sources in the revised 3C catalogues at galactic latitudes /b/≥ 10° at 86, 178, 750, and 1,400 MHz. The analysis assumed a linear relation between the spectral index and the logarithm of the flux densities at 178 MHz, and was carried out separately for quasars, radio galaxies, and unidentified radio sources. Values obtained for α are shown tabulated. The similarity of values for radio galaxies and unidentified sources is evidence that the number of quasars among the unidentified sources is substantially less than the number of radio galaxies. The coefficient α is shown graphically for 54 quasars with /b/≥ 10° against the mean geometric frequency at which the spectral index was determined. With regard to the cause of the relationship between quasar spectral indexes and flux densities, this cannot be explained by the curvature of the averaged emission spectrum, and the most probable cause is considered to be the absence of quasars with small spectral indices and large redshifts, and this absence might be caused by the physical conditions of quasars with large redshifts differing substantially from the rest. It is possible that the Compton losses by relativistic electrons among the photons of the primeval radiation are significantly greater for sources with large redshifts. (UK)

27997 POSSIBLE PULSATION OF NEUTRON STARS AND NEUTRINO EMISSION. Bandyopadhyay, P.; Chaudhuri, Ray (Indian Statistical Inst., Calcutta). Lett. Nuovo Cim.; 3: 498-502(11 Apr 1970).

The possibility is considered of explaining the dissipation mechanism and the rate of increase in period, taking into account neutrino emission from a radially pulsating neutron star. (W.D.M.)

Solar Phenomena

Refer also to abstracts 27972, 28127, and 28130.

27998 (CSIRO-Trans-9340) A NEW MAGNETOGRAPH FOR THE SIMULTANEOUS MEASUREMENT OF THE LONGITUDINAL AND TRANSVERSE ZEEMAN EFFECT IN THE SOLAR SPECTRUM. Brueckner, G. Translated by M. Fremt (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia), from Z. Astrophys.; 68: 48-84(1968). 40p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 22: 36617.

27999 (CSIRO-Trans-9833) CALIBRATION OF RECORDS OF SOLAR MAGNETOGRAPH. Severnyi, A. B. Translated by M. A. Hinze (Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia), from Izv. Krym. Astrofiz. Observ.; 36: 22-50(1967). 45p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 21: 36997.

28000 (N-70-23208) NONTHERMAL HEATING IN THE TWO-FLUID SOLAR-WIND MODEL. Hartle, R. E.; Barnes, Aaron (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr 1970. 47p. (NASA-TM-X-63864; X-621-70-114). CFSTI.

The two-fluid solar-wind model predicted values for wind speed and proton temperature that are lower than average observed values; however, the predictions are consistent with the empirical relation of Burlaga and Ogilvie in which the square root of the proton temperature is proportional to the wind speed. Since observed values of wind speed and proton temperature are typically higher than those of the two-fluid model, it is concluded that energy must be supplied by dissipation of nonthermal energy from an external source. The two-fluid model is therefore extended by including ad hoc an energy source in the proton heat equation whose strength and spatial distribution is varied to determine the general requirements of such a source. (auth) (STAR)

28001 POSSIBLE CLUES TO THE EARLY HISTORY OF THE SOLAR SYSTEM. Mabuchi, H.; Masuda, A. (Tokyo Univ.). Nature (London); 226: 338-9(25 Apr 1970).

A problem in connection with the nucleosynthesis of the light elements D, Li, Be, and B has been to decide whether preplanetary matter at an early stage of the solar system was intensely irradiated by solar particles. This motivated searches for anomalies in the isotopic abundances in meteorites. Within experimental accuracies these abundances were found to be identical with those of terrestrial matter (except for Li) and for this reason, and because of recent theoretical considerations, the tendency is to abandon the irradiation mechanisms. The present authors, however, thought it worthwhile to continue the studies, improving the experimental accuracy, and looking for abundance anomalies caused by other types of nuclear reactions. The previously adopted mean proton energy of 570 MeV was found too high, based on recent observations of solar-flare particles. Also, using the spectra of contemporary solar particles, isotopic anomalies in the products from high-energy nuclear reactions such as those on ^{50}V or ^{54}Cr would be less probable; neutron-induced reactions would also be less important because of the lower neutron production with softer primaries. Other nuclear reactions, induced by low-energy protons and alpha particles, were therefore considered,

including ^{138}Ba (p,n) ^{138}La and ^{180}Hf (p,n) ^{180}Ta; these were considered suitable since ^{138}La and ^{180}Ta are very low in cosmic abundance compared with the target nuclides. Nuclear reactions possibly giving rise to an isotopic abundance anomaly of ^{138}La and ^{180}Ta are listed. The abundance ratios of product nuclide to target nuclide in the preplanetary matter were taken to be the same as the cosmic abundances for nonvolatile elements and Cameron's new cosmic abundances were employed. Measurements of the sensitivity of each reaction, that is, the integrated flux of irradiating particles that may cause a 1% relative anomaly in isotopic abundance ratio, are given. Another advantage of ^{138}La and ^{180}Ta is that the (p,n) reaction is efficient only when the irradiated matter is of low density, such as gas or dust clouds, and this may lead to information about the state of preplanetary matter at the time of irradiation. Apart from the problem of the early solar system, their reactions combined with ^{56}Fe(p,n)^{56}Co, will be useful for investigations of the history of solar-flare activity using lunar surface material. (UK)

28002 POLARISATION REVERSAL OF SOLAR MICROWAVE BURSTS. Ramaty, R.; Holt, S. S. (Goddard Space Flight Center, Greenbelt, Md.). Nature (London); 226: 68-9 (4 Apr 1970).

High-resolution observations of solar microwave bursts have recently been reported, and these bursts were well correlated with distinct sunspots. Some details are given of an event on Jan. 18, 1969, including the sense of circular polarization of each source and the maximum flux density of the combined emission. Each source had an opposite polarization sense and, as a function of frequency, the sense of circular polarization reversed separately for each source. The polarization of one source showed a definite movement with an estimated velocity of about 2,500 km/sec. The various theories that may account for polarization reversal are briefly discussed, and attention is called to a mechanism (Holt and Ramaty, Solar Phys. 8: 119(1969) and Astophys. J. 158: 753(1969)) that appears capable of accounting for both the polarization and the spectrum of Jan. 18th. Using a detailed theory of gyrosynchrotron emission and absorption in a homogeneous and uniform magnetoactive plasma, it is shown that the spectrum and time profile of the microwave burst cannot be reconciled with the concurrent x-ray emission unless gyrosynchrotron absorption by the radiating electrons is taken into account. At high frequencies, where the source is optically thin, the intensity decreases with increasing frequency and the extraordinary mode dominates. At low frequencies the source is optically thick, so that the intensity increases with frequency and because the radiating electrons are nonthermal the ordinary mode dominates. The transition from the optically thick to the optically thin requirements therefore corresponds to a maximum in the emission spectrum and a reversal in polarization sense. The movement of the polarization centre cannot, however, be accounted for unless a more realistic field structure is used, but the rapid movement seems to imply that the polarization character of the emission is intrinsic to the radiation mechanism. (UK)

28003 THE SOLAR H AND K LINES. Linsky, Jeffrey L. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo. Univ. of Colorado, Boulder); Avrett, Eugene H. Publ. Astron. Soc. Pac.; 82: 169-248(Apr 1970).

Current understanding of the formation of the Ca II H and K resonance and infrared triplet subordinate lines in the Sun is reviewed, in view of the wealth of observations of these lines and the development of non-LTE line formation theory. The low- and high-spatial resolution data of these lines on the solar disk, off the limb, and in stellar spectra are described, along with observations of the analogous Mg II resonance lines. The various explanations proposed for the observed features of the lines including the double reversal, limb darkening, plage and spot profiles, and the anomalous line ratios are reviewed. Line profiles are computed according to a first-order steady-state theory in which a one-component atmosphere in hydrostatic equilibrium, noncoherent scattering, and a five-level atom and continuum representation for Ca II are assumed. The chromospheric model chosen is meant to be representative rather than definitive, but it produces profiles of all five lines and a microwave continuum in agreement with observations at the center of the disk. Extensions of this first-order theory are discussed. (auth)

28004 STUDY OF THE SOLAR CONTINUUM IN THE INTERMEDIATE INFRARED SPECTRAL RANGE 3.5 TO 24.4 mu. Koutchmy, S.; Peyturaux, R. (Institut d'Astrophysique, Paris). Astron. Astrophys.; 5: 470-87(May 1970). (In French).

Several series of measurements of the solar continuum intensity of the center of the disc I_λ (0.0) were made in the Pyrénées Mountains at an altitude of 1600 m, in excellent meteorological conditions. The chosen spectral resolution ($\lambda \cdot \Delta\lambda^{-1} \geq 100$) was sufficient to make measurements in the water vapor atmospheric windows of the studied wavelength, the signal-to-noise ratio being kept S/B > 100. A new method for checking the variations of the vertical water vapor equivalent W_v during the observations is described, and its exploitation is discussed. The drawing of the Bouguer Lines was replaced by a system of linear algebraic equations. The value of I_λ (0.0) was also graphically determined. The measurements of the spectral ranges 3.5 to 5 μ, 8 to 13 μ, and 17 to 25 μ are successively outlined, the method used being different. The models of the graphite and metal black bodies used are described and a new empirical method for testing them is presented. It was found that the atmosphere attenuation within the spectral windows is well correlated with the quantity of equivalent water vapor if its variations are taken into account and if the adapted calibrations are used within the telluric band ϕ, for the application of the spectroscopic method. The radiative balance, including the detector and the various sources, was studied so as to exactly compensate the atmospheric thermal radiation and the radiation of the detector. The telluric spectra of the whole region studied with weak dispersion conditions are also given. (TSS) (auth)

28005 CHARACTERISTIC PROPERTIES OF SMALL CHAINS OF TYPE-I SOLAR RADIO BURSTS. Elgaroey, Oe.; Ugland, O. (Inst. of Theoretical Astrophysics, Oslo). Astron. Astrophys.; 5: 372-81(May 1970).

During solar radio noise storms, bursts of spectral Type I are emitted in large numbers. Sometimes several bursts occur in close succession and form a chain in the frequency-time plane. Using high-resolution dynamic records obtained at the Oslo Solar Observatory, properties of short-lasting chains such as lifetime, bandwidth, frequency drift, and fine structure were determined. A possible interpretation of the observational results is discussed. (auth)

28006 AN ATTEMPT TO MEASURE THE SOLAR LIMB DARKENING USING THE LUNAR PROFILE DURING THE ECLIPSE OF MAY 20, 1966. Magnant, F. (Observatoire, Meudon, France). Astron. Astrophys.; 5: 382-90(May 1970). (In French).

An experiment was performed at the solar eclipse of May 20, 1966, in order to measure the integrated brightness distribution E(h) of the solar limb in the continuous spectrum, on the violet side of the Balmer discontinuity (3650 Å) and in the red at 6045 Å. The observing methods, which are new in several respects, are described and the available data are analyzed. In the red, no reliable results could be obtained due to improper photometric calibrations, and only an upper limit for the brightness of spicules in the continuum is given. After a discussion of the use of the slitless spectrograph in the measurement of narrow continuum windows, a curve for E(h) in the Balmer continuum is given. (auth)

28007 THE CHARACTERISTIC SIZES AND THE ELECTRON DENSITY OF CORONAL ENHANCEMENTS OBSERVED IN WHITE LIGHT. Leblanc, Y. (Observatoire, Meudon, France); Leroy, J. L.; Poulain, P. Astron. Astrophys.; 5: 391-9(May 1970).

A method is developed that allows the calculation of the characteristic sizes, the vertical density gradient, and the electron density of coronal enhancements. This method is applied to observations collected with the K coronameters of Haleakala-Mauna Loa Observatory (1964) and the Pic-du-Midi Observatory (1968-1969). Twenty enhancements were studied. The following results were found: most of the enhancements have an elliptical section, the longitudinal extent being larger than the latitudinal one. Typical sizes for the semi-major axis and for the semi-minor axis are $0.26 \mp 0.03\ R_\odot$ and $0.17 \pm 0.03\ R_\odot$. It is found that the total electron density in an enhancement is two or three times that of the background at the time of minimum solar activity, and two to four times in maximum period. The electron density derived for each enhancement is thought to be given with an accuracy of ∓10%. The vertical density gradient ($\Delta \log Ne/\Delta z$) is generally not equal to the "quiet corona" one. It seems that it is smaller when the enhancement is associated with an old plage region, and generally bigger when it is associated with a young active region. (auth)

28008 MONOCHROMATIC CORONA DURING THE MINIMUM SOLAR ACTIVITY IN 1964. Rajkova, Donka. Izv. Sekts. Astron., Bulg. Akad. Nauk.; 3: 143-52(1969). (In French).

The changes are followed up in the green coronal line (5303 Å) around the minimum of solar activity in 1964 on the basis of observations from Pic du Midi and Kislovodsk. The N-S and E-W asymmetry is calculated. The intensity scales of the two stations are compared. The behavior of the red line is followed up in ac-

cordance with observations from Kislovodsk. It is established that the Kislovodsk observations do not confirm the maximum of the red line (6374 Å) in 1963. (Abstr. Bulg. Sci. Lit.)

28009 STUDY OF THE IMPORTANCE OF SUNSPOTS AND THEIR VARIATION. Lopez Arroyo, M. Bol. Astron. Observ. Madrid; 7: No. 1, 3-47(1968). (In Spanish).

A study is presented of the importance of the sunspots recorded in the Photoheliographic Results of Greenwich, on the basis of their lifetime and maximum area. The sunspots considered were observed during the years 1878.9 to 1954.3, corresponding to cycles 12 to 18. It is shown that the frequency distribution of sunspots as a function of their lifetime and maximum area can be regarded as log-normal in every cycle. It is also seen that the mean importance varies regularly from cycle to cycle and that this variation is probably itself cyclic, with a period of seven or eight 11-year solar cycles. (IAA)

28010 FORECASTS OF SOLAR ACTIVITY. Fortini, T.; Torelli, M. (Osservatorio Astronomico, Rome). Osserv. Astron. Roma, Contrib. Sci.; No. 71, 591-6(1968). (In Italian).

A brief review is given of some of the principal methods currently used in forecasting solar activity. Only methods based on sunspots and solar flares are treated. It is pointed out that the current knowledge of the phenomenology and physics connected with solar activity does not make possible adequate forecasts of the general characteristics of solar activity. (IAA)

28011 PHYSICS OF THE SUNSPOTS. PART II. Jakimiec, Jerzy. Postepy Astron.; 18: 3-18(Jan-Mar 1970). (In Polish).

Basic results of the observations of sunspot magnetic fields are considered. Moreover, main results of the theory of the convection in the magnetic field are quoted, and their application to sunspots is discussed. (auth)

28012 HEATING OF THE SOLAR CORONA. Krelowski, Jacek. Postepy Astron.; 18: 19-42(Jan-Mar 1970). (In Polish).

A concise relation is presented of the most important theories concerning the heating of the solar corona, developed in the last twenty-odd years. A discussion of the already historical studies of Schwarzschild, Schatzman, and Alfvén is given, as well as the modern, recently published works of Osterbrock, Uchida, Whitaker, and Kuperus. The main arguments for as well as against the mentioned theories are presented. Observational data are not given. (auth)

28013 THE SOLAR (STELLAR) WIND AS A ONE-DIMENSIONAL FLOW. PART II. Grzedzielski, Stanislaw. Postepy Astron.; 18: 43-57(Jan-Mar 1970). (In Polish).

Some simple consequences are considered that result from the introduction into the description of the solar wind of the effects induced by (1) the magnetic field and (2) the thermal conductivity of the gas. (auth)

28014 LINE LIST FOR AN IRON-SPARK SPECTRUM (10 TO 18 A). Cohen, Leonard (Goddard Space Flight Center, Greenbelt, Md.); Feldman, Uri. Astrophys. J.; 160: L105-6(May 1970).

A low-inductance 17 to 19 kV vacuum spark was used to generate spark spectra of iron electrodes. Wavelengths and visually estimated intensities are given for the region 10 to 18 Å. (auth)

28015 SAMPLE MODELING IN THE GRAVITATIONAL FIELD OF THE SUN. Petrov, A. Z. (Kazan State Univ.). Dokl. Akad. Nauk SSSR; 190: 305-8(11 Jan 1970). (In Russian).

The gravitational field was examined on the basis of Einstein's theory, considering the equation of motion of the examined bodies. It was shown in an earlier study that if the geodetic lines of two fields coincide by reflection, the fields differ only slightly from each other. This problem was generalized, considering a Riemann space that identifies the gravitational field and examining the properties of this "model." Application of the derived equations indicated that the Einstein theory of the Sun's gravitational field may be used for a sample modeling in the plane space, when the orbits of the planets and the light rays passing near the Sun are mocked up by nongeodetic curves, determined by Lorentz-type equations of motion; the "field tension" of this model satisfies the Maxwellian equations. The "energy" of the gravitational field of such a model is defined by a finite negative value. (auth)

28016 LARGE-SCALE SOLAR CONVECTION. Davies-Jones, Robert P.; Gilman, Peter A. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 12: 3-22(Apr 1970).

The effects of rotation about a vertical axis on thermal convection with a simple model in which an inviscid, incompressible fluid of zero thermal conductivity and electrical resistivity is contained in a thin annulus of rectangular cross section were examined. The initial steady state assumed is one of no motion relative to the rotating frame with constant (unstable) vertical temperature gradient and uniform toroidal magnetic field. Small periodic disturbances are than introduced and the linearized perturbation equations solved. The second order mean circulations and magnetic fields that are forced by nonzero Reynolds and thermal stresses and magnetic field transports were also determined. The solutions have several properties relevant to large-scale solar phenomena if giant long-lived convection cells exist on the Sun. In particular, the convective cells are tilted in latitude in the same sense as bipolar magnetic regions, and induce vertical magnetic fields with the same tilt. They transport momentum across latitude circles through Reynolds stresses and induced meridional circulations thus setting up a differential rotation. Cells which grow slowly compared to the rotation rate and have comparable dimensions in latitude and longitude transport momentum toward the equator. The cells also form a poloidal magnetic field from initial toroidal field, in a manner similar to that put forth by Parker. (auth)

28017 SPECTROSCOPIC DETERMINATIONS OF SOLAR ROTATION. Howard, Robert; Harvey, J. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Solar Phys.; 12: 23-51(Apr 1970).

Spectral line shift data obtained from full-disk magnetograms recorded at Mt. Wilson are analyzed for differential rotation. The method of analysis is discussed and the results from the data for 1966 through 1968 are presented. The average equatorial velocity over this period is found to be 1.93 km/sec or 13.76 deg/day (sidereal). This corresponds to a sidereal period of 26.16 days. The average results are $\omega = 2.76 \times 10^{-6} - 3.51 \times 10^{-7} \sin^2 B - 4.43 \times 10^{-7} \sin^4 B$ rad/sec, where B is the solar latitude. This indicates a smaller decrease of angular velocity with latitude than found by earlier investigators. Variations from day to day are caused by large-scale short-lived velocity fields on the solar surface. There also appear to be secular variations. (auth)

28018 THE UV CONTINUUM 1450–2100 A AND THE PROBLEM OF THE SOLAR TEMPERATURE MINIMUM. Widing, K. G.; Purcell, J. D.; Sandlin, G. D. (Naval Research Lab., Washington, D. C.). Solar Phys.; 12: 52-62(Apr 1970).

This study is based on a set of ten solar rocket spectra well exposed for photometry photographed on July 27, 1966 by Purcell, Snider, and Tousey. The photometry of the far-uv continuum illustrates the transition of the solar temperature minimum at 1700 Å in the solar spectrum: (a) the continuum intensity decreases by 30 to 50% between 1700 Å and the ^{1}D limit of silicon at 1682 Å, and (b) the equivalent brightness temperature shows minimum values throughout the spectral range 1540 to 1682 Å, which average just under 4700 ± 100°K. The minimum-uv brightness temperature is 300°K higher than the far-infrared measurement of the solar minimum temperature, and possible reasons for this are discussed. Brightness temperatures measured in prominent CO band heads and in the aluminum 1937 Å auto-ionization line also are given. (auth)

28019 FREQUENCY DEPENDENCE OF THE LINE SOURCE FUNCTION. Canfield, Richard C. (Sonnenborgh Observatory, Utrecht). Solar Phys.; 12: 63-5(Apr 1970).

The author states that an error in a paper by Worrall (Solar Phys., 8: 18(1969)) leads him to the incorrect conclusion that the frequency independence of the line source function has the consequence that the spectral line must disappear at the solar limb. It is concluded that the spectral line may appear in absorption or emission. The line profile depends on the relative values of the (assumed frequency-independent) line and continuum source functions and on the ratio of line opacity to continuum opacity. (W.D.M.)

28020 FRAUNHOFER LINES WITHOUT ZEEMAN SPLITTING. Sistla, Gopal (State Univ. of New York, Albany); Harvey, J. W. Solar Phys.; 12: 66-8(Apr 1970).

For many solar observations, especially velocity measurements and evaluation of magnetic-field measurement errors, it is useful to observe Fraunhofer lines that do not exhibit the Zeeman effect. The results of a fairly thorough search for magnetically unaffected lines in the solar spectrum are presented. (W.D.M.)

28021 SIMULTANEOUS MEASUREMENTS OF MAGNETIC FIELDS AND BRIGHTNESS FIELDS USING A 4-IMAGE SPECTROHELIOGRAPH. Sheeley, N. R. Jr. (Kitt Peak National Observatory, Tucson, Ariz.); Engvold, O. Solar Phys.; 12: 69-83(Apr 1970).

The use of an auxiliary beamsplitter with the Kitt Peak 15-foot spectroheliograph permits spectroheliograms to be taken simultaneously in 4 identical images of the Sun. By using two of these images for a Zeeman spectroheliogram, a third image for a Fe I

λ4071 spectroheliogram, and the fourth image for a 6107 Å continuum spectroheliogram, simultaneous measurements of magnetic fields and brightness fields were obtained. Within the limits of intensity variations imposed by Doppler shifts and brightness fluctuations of the continuum, a quantitative relation does exist between the measured values of brightness and magnetic field strength of the photospheric network. For intensities measured +0.12 Å from the core of Fe I λ4071, this relation is $\ln(1 + \Delta I/I) = \alpha|B_{||}|$, where $B_{||}$ refers to the component of magnetic field normal to the solar surface, $\Delta I/I$ is the fractional excess of brightness of the magnetic regions relative to the brightness of nonmagnetic regions, and $\alpha = (6 \pm 2)\%/100$ gauss. (auth)

28022 LINE FORMATION IN A MAGNETIC FIELD AND THE INTERPRETATION OF MAGNETOGRAPHIC MEASUREMENTS. II. THE INFLUENCE OF DIFFERENT ATMOSPHERE MODELS AND OF A MAGNETIC FIELD GRADIENT. Staude, J. (Sonnenobservatorium Einsteinturm, Potsdam, Ger.). Solar Phys.; 12: 84-94(Apr 1970).

The solution of the equations of transfer for the Stokes parameters in a magnetic field given by Unno (1956) is generalized for a nonlinear source function. Model calculations were carried out for empiric atmosphere models of the photosphere and spots both for homogeneous magnetic fields and for a field-strength gradient. Their influence on line contours and magnetographic calibration curves is studied for the line Fe I λ5250.2 Å. (auth)

28023 DEPENDENCE OF SUNSPOT MINIMUM INTENSITY ON AREA. Rossbach, M.; Schroeter, E. H. (Univ., Goettingen, Ger.). Solar Phys.; 12: 95-100(Apr 1970).

Highly resolved photographs of 25 sunspots and pores of different areas in two continuous wavelengths, obtained in summer 1966 at the Sacramento Peak Observatory, were used to reinvestigate the dependence of sunspot minimum intensity on area. Special care was taken to correct for parasitic light caused by blurring or image motion and by light scattering in the instrument and atmosphere. A very small, if any, dependence of I_{min} on sunspot area was found in contradiction to older measurements but in agreement with Sitnik's and Zwaan's statements. (auth)

28024 THE POSSIBLE EXISTENCE OF HOH LINES IN THE SUNSPOT SPECTRUM. Mallia, E. A.; Blackwell, D. E. (Oxford Univ.). Solar Phys.; 12: 101-3(Apr 1970).

It is suggested that the presence of HOH lines in the umbral spectrum has not been demonstrated conclusively. It is clear that their detection is a difficult problem requiring for its achievement low noise spectra obtained when telluric lines are exceptionally weak. Spectra are shown that were not obtained on days of especially low humidity. (W.D.M.)

28025 ELECTRIC CURRENT IN A SUNSPOT. Jayanthan, R. (Univ. of Michigan, Ann Arbor). Solar Phys.; 12: 104-5(Apr 1970).

An observation of a total electric current of magnitude 3.8×10^8 amperes per kilometer height in a δ-type sunspot is described. (W.D.M.)

28026 NEW OBSERVATIONAL RESULTS FOR THE SOLAR CHROMOSPHERE. Banos, G. J.; Macris, C. J. (National Observatory, Athens). Solar Phys.; 12: 106-14(Apr 1970).

High-resolution photographs of the solar chromosphere were obtained with the 40-cm refractor of the Athens Observatory and a 0.5 Å 'Halle' Hα filter. The best photographs show a resolution of 0.6", which is comparable with the theoretical resolving limit of 0.4", at Hα. The achieved resolution permitted some excellent observations of the fine structure of the chromosphere on the disk as well as on the limb. The study of these observations leads to the following results: (a) the bright filaments of the disturbed chromosphere as well as the penumbral ones appear to consist of knots; (b) inside the cells of the chromospheric network of the quiet chromosphere, bright roundish granule-like formations are present, their mean size being of the order of 2500 km; and (c) the bright fine mottles seem to lie at the root of the elongated dark ones, each pair of them giving rise to a spicule. (auth)

28027 SUDDEN DISAPPEARANCE OF A LARGE QUIESCENT PROMINENCE ON THE SOLAR DISK, APRIL 28, 1967. McCabe, Marie (Univ. of Hawaii, Honolulu). Solar Phys.; 12: 115-24 (Apr 1970).

Observations are described of the sudden disappearance of a long quiescent filament whose development could be traced through four rotations from its first appearance on the disk between two well-separated active centers. Following the disappearance, plage-like chromospheric brightenings were observed on either side of the filament axis, with the separation distance increasing with time. The results are discussed in relationship to models in which the prominence is supported by photospheric magnetic fields and the brightenings results from the gravitational fall of material following the prominence eruption. (auth)

28028 INTERPRETATION OF TYPE I- AND IV mB-BURSTS AND NOISE STORMS BY MODE COUPLING IN THE WARM PLASMA. Mollwo, L. (Zentralinstitut fuer Solar-Terrestrische Physik, Berlin). Solar Phys.; 12: 125-42(Apr 1970).

The circular polarization of radiation emitted from the solar type-I- and -IV mB bursts and noise storms is not understood very well. For an attempted new explanation, the dispersion equations for the ordinary (left-handed) and the extraordinary (right-handed) wave are derived from the well-known tensor conductivity of warm plasma proposing a very small angle ϑ between the magnetic field and propagation direction, and the plasma parameters $X \approx 1$, $Y \approx 1$. Taking into account a plasma temperature different from zero, conditions of a coupling point (Budden, 1961) are attained very nearly even if the very small collision frequency is neglected. It is shown that the observed ordinary (left-handed) polarization may be explained by a process of mode coupling between the originally emitted extraordinary (right-handed) wave and the resulting ordinary wave. The source of the right-handed radiation may be gyro radiation or Cherenkov radiation. The proposed mechanism is in accordance with the main observational facts. It remains open whether the known magnetic asymmetry of active regions accounts for the prevailing left-handed polarization. (auth)

28029 SOME OBSERVED CHARACTERISTICS OF SOLAR RADAR ECHOES AND THEIR IMPLICATIONS. James, Jesse C. (Massachusetts Inst. of Tech., El Campo, Tex.). Solar Phys.; 12: 143-62(Apr 1970).

The results of a series of radar studies of the Sun at 38.2 MHz are presented. The echoes imply ever-present compressional waves in the corona, and these waves are likely associated with coronal heating. Some echoes are refracted by plasma clouds high in the corona. Other echoes are reflected by dense plasma irregularities moving outward very slowly at 0 to 20 km/sec. These are sometimes found as far out as three solar radii from the Sun's center. Suggestions for future solar radar experiments and the need for them are outlined. (auth)

28030 HERSCHEL EFFECT AND SOLAR PHOTOGRAPHY. Jayanthan, R. (Univ. of Michigan, Ann Arbor). Solar Phys.; 12: 163-6(Apr 1970).

A method of photographing the solar image in the uv part of the solar spectrum is described. The resulting images show the bright photospheric network of Sheeley and Chapman; these have been recorded at the small central distance of 20'. During a flare of importance 1b near a spot group, no detectable changes in the spots, their relative positions or the bright photospheric network could be observed. (auth)

28031 DETERMINING THE COMPOSITION AND HISTORY OF THE SOLAR SYSTEM. Herzog, L. F. (Nuclide Corp., State College, Pa.). Int. Ser. Monogr. Anal. Chem.; 35: 1-59 (1970).

The theme of this review is what is known at present on the subject and what it is hoped to learn from space probes. Headings are as follows: Introduction; compositional data in solar system objects (solar and "cosmic" abundances; the Earth and the meteorites—chemical composition of terrestrial igneous rocks, chemical composition of meteorites, major element variations in igneous rocks and meteorites, trace element variations in igneous rocks and meteorites, interpretation of a single chemical analysis, and composition of the terrestrial atmosphere; the Moon—physical characteristics and origin of lunar surface features; composition of the lunar surface layer; determination of the mineralogy and petrology of a sample on the surface of the Moon from its chemical analysis; and the lunar atmosphere; Mars; Mercury; Venus; Jupiter; Saturn; Uranus; Neptune; Pluto; asteroids, comets, and interplanetary dust). (66 references) (UK)

28032 NEW CLASSIFICATIONS OF EMISSION LINES OF HIGHLY IONIZED PHOSPHOROUS AND SULPHUR. Fawcett, B. C.; Hardcastle, R. A.; Tondello, G. (Culham Lab., Abingdon, Eng.). J. Phys., B (London); 3: 564-71(Apr 1970).

The spectra of laser-produced plasmas emitted from targets of pure sulphur and phosphorus in the wavelength region between 20 and 300 Å were analyzed. As a result over fifty newly classified lines of sulphur X to XIV and sixteen of phosphorus XI to XIII are reported and a further 150 previous identifications in phosphorus VI to XIII are confirmed. (auth) (UK)

28033 SOLAR ACTIVITY INDEX: VALIDITY SUPPORTED BY OXYGEN ISOTOPE DATING. Bray, J. R. Science; 168: 571-2(1 May 1970).

A significant correlation between ^{18}O concentration in a Greenland ice core and an index of solar activity supports the validity

of the solar index. The correlation may result from an apparent control of temperature by solar activity. (auth)

28034 RADIOACTIVITY INDUCED IN APOLLO 11 LUNAR SURFACE MATERIAL BY SOLAR FLARE PROTONS. Heydegger, H. R.; Turkevich, Anthony (Univ. of Chicago). Science; 168: 575-6(1 May 1970).

Comparison of values of the specific radioactivities reported for lunar surface material from the Apollo 11 mission with analogous data for stone meteorites suggests that energetic particles from the solar flare of April 12, 1969 may have produced most of the cobalt-56 observed. (auth)

28035 INTERSTELLAR HYDROGEN DENSITIES IN THE SURROUNDINGS OF THE SOLAR SYSTEM. Fahr, H. J. (Univ., Bonn). Nature (London); 226: 435-6(2 May 1970).

It is usually assumed that the solar system is embedded in a region of neutral interstellar hydrogen (an H I region), but hitherto it has not been possible to measure the density of this interstellar medium. It is considered, however, that a density value for this medium might be obtained if the measured Lyman-α background can be ascribed to scattering of the solar Lyman-α radiation by the neutral hydrogen near the Sun, an assumption that seems plausible from the findings of Blum and Fabr that some of the peculiar features of Lyman-α measurements can be explained on this basis. If the assumption is correct it could appear that the solar system is immersed in a very low density of interstellar hydrogen (0.06 cm^{-3}). (UK)

Galaxies

28036 FURTHER EVIDENCE FOR THE OCCURRENCE OF A BROAD INTERSTELLAR ABSORPTION BAND IN THE FAR-ULTRAVIOLET. Nandy, K.; Seddon, H. (Royal Observatory, Edinburgh). Nature (London); 226: 63-4(4 Apr 1970).

It was earlier suggested by the authors that there may exist in the far-uv a broad absorption band of the same type as already observed in the visible region, and the purpose of the present communication is to present further data to confirm the occurrence of such a band, based on measurements of the uv extinction from rocket observations and the uv peak of the interstellar extinction curve. It has also been suggested that interstellar dust grains may be a mixture of graphite and silicate particles. The extinction curve which gives the best fit with observations is derived by a model in which extinction by graphite particles at λ = 4500 Å is four times the extinction that arises from silicate particles at that wavelength. Near $1/\lambda = 4.5\ \mu m^{-1}$ where the uv peak occurs, however, the difference between theory and observation is much larger than the error of observations, indicating that an interstellar absorption band occurs close to this wavelength. Additional support for this view can be found in the data on the measurements of the diffuse galactic radiation now available over a wide-wavelength range. Strong interaction of the starlight with interstellar dust grains becomes evident from recent measurements of interstellar extinction, but the very low value of the albedo in the narrow spectral range 2100 to 2800 Å, as compared with its values at other wavelengths implies that the energy of the starlight in this wavelength region is truly absorbed. This also adds additional weight to the suggestion that a broad interstellar absorption feature occurs close to 2200 Å. (UK)

28037 KERR METRIC BLACK HOLES. Bardeen, J. M. (Univ. of Washington, Seattle). Nature (London); 226: 64-5 (4 Apr 1970).

It has been suggested (Lynden-Bell, Nature 223: 690(1969)) that a massive collapsed object may lie at the centre of many galaxies and that a continuing flux of matter into such an object ("black hole") may be the source of energy for the nonthermal radiation observed from some galactic nuclei. The metric used to describe the geometry of space-time in the vicinity of the collapsed object has been the spherically symmetric Schwarzschild metric, which is valid only if the collapsed object has zero angular momentum. It would be expected that any collapsed object of the kind considered would possess considerable angular momentum, since a great deal of such momentum must be lost from a typical galactic nucleus to permit collapse inside the gravitational radius in the first place. It is thought that very probably the metric describing a collapsed object with angular momentum is the Kerr metric (Phys. Rev. Lett. 11: 522(1963)), which represents a stationary axially symmetric solution to the vacuum Einstein equations with two free parameters. It appears that this metric is the only stationary asymptotically flat vacuum metric which has a nonsingular event horizon, and it is strongly suggested that the irreversible gravitational collapse of a rotating body inside a trapped surface will result in the exterior metric in the region outside the trapped surfaces asymptotically approaching the Kerr metric as the transient gravitational waves die. Additional evidence comes from calculations which show that in quasi-stationary collapse of a uniformly rotating disk that exterior metric becomes the Kerr metric as the redshift from the centre of the disk becomes infinitely large. After the initial collapse there is likely to be continued accretion of matter, at least if the 'black hole' is in a galactic nucleus, and it is assumed that this accretion will take place from a disk rotating in the equational plane of the collapsed object. An accreting matter element slowly loses angular momentum in the disk due to torques exerted by magnetic fields until it reaches the radius of the innermost stable orbit in the equatorial plane, at which point it falls into the 'black hole' without further loss of energy and angular momentum. The total gravitational mass and angular momentum of the 'black hole' are changed by the energy for unit mass and angular momentum per mass unit of the innermost stable circular orbit, times the rest mass accreted. Solutions to the geodesic equations for the Kerr metric were obtained. If the accreting matter does not all have positive angular momentum the argument fails, since the cross section for trapping accreting matter is lower for matter with negative angular momentum than for matter with positive angular momentum. In a galactic nucleus, however, the matter can be expected to have angular momentum from the rotation of the galaxy. (UK)

28038 IS MAGNETIC ALIGNMENT OF INTERSTELLAR DUST REALLY NECESSARY? Harwit, M. (Astronomical Inst., Prague). Nature (London); 226: 61-2(4 Apr 1970).

The idea of interstellar grains aligned by magnetic fields has been generally accepted, principally because there existed no known alternative mechanism which would yield the general alignment parallel to the galactic plane. There have, however, been persistent difficulties with the magnetic theories, and evidence for magnetic alignment is also weak on the observational side. The purpose of the present communication is to show that there is a quite straightforward alternative alignment mechanism and that it produces a degree of polarisation roughly consistent with observations. (TSS) (UK)

28039 INFRARED SPECTRUM OF THE GALACTIC CENTRE. Okuda, H. (Kyoto Univ.); Wickramasinghe, N. C. Nature (London); 226: 134-5(11 Apr 1970).

Evidence is available concerning an extended infrared source near the centre of the Galaxy; a dimension of ~1 pc has been suggested for the 10-μm radiation, and ~100 pc for the 100-μm radiation, and the shape of the infrared spectrum is fairly well known, particularly over the waveband 5 to 22 μm. The flux determination at 100 μm is somewhat less certain, whilst only an upper limit is available for the flux at 1000 μm. It is also known that the spectrum of the galactic centre source in the range 5 to 22 μm bears a striking resemblance to that of several Seyfert nuclei; and this suggests that similar radiation mechanisms may operate. Models proposed for the infrared radiation of Seyfert galaxies are of two main categories: (a) nonthermal synchrotron emission from relativistic electrons and (b) thermal emission from dust grains surrounding a central uv source, and in some respects dust models may be preferable. It has also been argued that dust grains could be retained near intense uv sources due to their photoelectric charge and the consequent coupling of grains to the surrounding H II gas. It is of interest to determine whether recent available data concerning the galactic centre source are consistent with the proposed class of dust model, and the results are presented of some numerical calculations for the infrared spectrum of the galactic centre on the basis of a dust model. It is assumed that the central source has an effective temperature of ~50,000°K and radiates like a black body. It would appear that the calculations favour a model in which the dust shell surrounding the central uv source has a more or less sharply defined outer boundary, and a sharp cutoff in the grain density could occur if grains are decoupled from the surrounding gas due to a sharp reduction of photoelectric charge. For an optically thin dust shell surrounding a central uv source it would also be expected that the diameter of the associated infrared source would increase with wavelength. If the 10-μm radiation orginated from a region with diameter 1 pc, the 100-μm radiation would have an extent of ~300 pc, which is not inconsistent with current data. The diameter might be reduced by a factor of three or more if the dust shell were optically thick in the uv. (UK)

28040 HIGH-RESOLUTION MEASUREMENTS OF THE GALACTIC RADIO SPECTRUM. Landecker, T. L.; Wielebinski, R. (Univ. of Sydney). Proc. Astron. Soc. Aust.; 1: 210-11 (Mar 1969).

High-resolution surveys of the galactic radio emission show detailed structure both near the galactic plane and at high galactic latitudes. Some of this structure is describable as "spurs" while the rest comprises isolated features. Measurements of the spectral index of the background radiation with a resolution of 3.5° are described. These measurements were aimed at a detailed understanding of the high-latitude synchrotron emission. (W.D.M.)

28041 GALACTIC MAGNETIC FIELD. Mathewson, D. S. (Australian National Univ., Canberra). Proc. Astron. Soc. Aust.; 1: 209-10(Mar 1969).

In an attempt to determine the spatial distribution of the helical and longitudinal components of the magnetic field, the polarization of southern stars at distances up to 3000 pc was measured using the 24-inch rotatable siding spring telescope. In addition, northern hemisphere optical polarization data were collected from the surveys of Hiltner, Hall, Behr, Loden, and Appenzeller. (W.D.M.)

28042 NEW CHARACTERISTICS OF COMA CLUSTER OF GALAXIES. Kalinkov, M. Compt. Rend. Acad. Bulg. Sci.; 23: 9-12(1970).

An attempt is made to establish some new morphological and statistical characteristics of the Coma cluster. It is concluded that genuine spheroidal systems are located in the central part of the cluster, the galactic nuclei are less flattened than the galaxies, and the visible flattening of the cluster defines the position of the axis of rotation. (W.D.M.)

28043 INTEGRATED MAGNITUDES OF M33 AND M101. Jacobsson, S. (Uppsala Astronomical Observatory). Astron. Astrophys.; 5: 413-15(May 1970).

The integrated magnitudes and colors in the UBV system were found to be B = 6.50m, B − V = 0.65m, and U − B = 0.00m for M 33 and B = 8.43m, B − V = 0.45m and U − B = 0.08m for M101. (auth)

28044 SPIRAL-ARM STRUCTURE AND HIGH-VELOCITY GAS AT INTERMEDIATE LATITUDES. Kepner, M. (Sterrewacht, Leiden). Astron. Astrophys.; 5: 444-69(May 1970).

An intermediate latitude 21-cm survey was made within the region $228° \geq l \geq 48°$ and $20° \geq b \geq 6°$ in order to investigate the structure of the spiral arms away from the galactic plane and to search for high-velocity features beyond the immediate solar neighborhood. An approximate gaussian analysis was used to separate the profile contributions resulting from simple extensions of spiral arm structure and those of other features. This analysis indicated that the spiral arms extend to 1 to 2 kpc above the galactic plane, with possible extensions to more than 3 kpc above the arm density maximum in a few cases. (TSS) (auth)

28045 NEW INTERACTION BETWEEN GALAXIES AND STARS OF THE TYPE OF ELECTROMAGNETIC INTERACTION. Kalicin, Nikola St. Izv. Sekts. Astron., Bulg. Akad. Nauk.; 3: 19-36(1969).

Connecting links (bridges, tails, etc.) formed by stars are observed in the case of interacting galaxies. The author explains these interactions of the galaxies by forces of the type of the electrostatic and magnetic ones. The assessments show that the observed peculiarities of the groups of galaxies and within the individual galaxies may be explained by these forces. (Abstr. Bulg. Sci. Lit.)

28046 ORIENTATION OF THE MAGNETIC FIELD IN M31. Noerdlinger, Peter D. (Ames Research Center, Moffett Field, Calif.). Astrophys. J.; 160: 785(May 1970).

Pooley's (M.N.R.A.S., 144: 101(1969)) recent study of continuum radio emission from M31, in which he concluded that the field may be turbulent, is discussed briefly. It is maintained that although the data still show that the field is not perfectly aligned, some modest departures ought to suffice to fit the data. (W.D.M.)

28047 SPECTROSCOPIC SURVEY OF COMPACT AND PECULIAR GALAXIES. Sargent, Wallace L. W. (Carnegie Institution of Washington, D. C.). Astrophys. J.; 160: 405-27 (May 1970).

Low-dispersion spectrograms were obtained for 141 objects in Zwicky's first five lists of compact galaxies. These 141 objects were largely but not completely selected for their blue appearance on the Sky Survey prints. Direct photographs were obtained at the 200-inch prime focus of a representative sample of thirty objects. Photoelectric observations were made for forty-four galaxies. The spectra show ten objects to have Seyfert-like emission lines; thirty-three to have sharp emission lines; twenty to have both absorption lines and sharp emission lines; sixty to have absorption lines; and three to have continuous spectra. The remaining objects were galactic stars and one planetary nebula. The UBV colors of the galaxies are correlated with the spectra. Individual descriptions of the 126 galaxies, including their redshifts and absolute magnitudes, are given. The mean redshift is 9994 km sec^{-1}, and the mean absolute magnitude is $M_p = -20.2$. The galaxies are a very heterogeneous collection with a range in absolute magnitude $-14.9 > M_p > -23.2$. The galaxies with sharp emission lines are probably excited by hot stars. Many new interesting objects are described, including field galaxies with high intrinsic luminosities, four new Seyfert galaxies, a new "ring" galaxy, and several dwarf galaxies with very strong, sharp emission lines. It is shown that the galaxies for which 200-inch photographs were obtained are indeed compact in the sense of having an abnormally high luminosity per square parsec. (auth)

28048 PHYSICAL CONDITIONS IN THE NUCLEUS OF M82. Peimbert, Manuel (Univ., Mexico, Mexico City); Spinrad, Hyron. Astrophys. J.; 160: 429-41(May 1970).

Narrow-band photoelectric photometry of the nucleus and a bright region northeast of the center of M82 was carried out with the 120-inch telescope at Lick Observatory. The intensity of several emission lines in the nucleus, as well as of the continuum in both regions at different wavelengths, was obtained. From the Balmer and Paschen emission lines of hydrogen, an interstellar absorption of 4.23 mag at Hβ was derived for the nucleus. Collisions by thermal electrons are not responsible for the ionization in the nuclear region: this result and the observed Balmer decrement led to the adsorption of radiation as the principal mechanism of ionization. The thermal contribution to the radio flux is smaller than 10% in the most favorable wavelengths. By extrapolating the radio spectrum to below the Lyman limit on the basis of a model of a single electron reservoir, synchrotron radiation fails by at least two orders of magnitude for the excitation of Hα in the nucleus; furthermore, the synchrotron contribution to the visible region of the spectum is negligible. The $N(He^+)/N(H^+)$ ratio is 0.065; however, a large fraction of the helium atoms is neutral, and the N(He)/N(H) ratio is about 0.13. The observed Balmer jump is smaller in the nucleus than in the region northeast of it. It is found that the spectral type of the galaxy becomes progressively later from the center outward. (auth)

28049 COLLECTIVE INSTABILITIES AND WAVES FOR INHOMOGENEOUS STELLAR SYSTEMS. I. THE NECESSARY AND SUFFICIENT ENERGY PRINCIPLE. Kulsrud, Russell M.; Mark, James W-K. (Princeton Univ., N. J.). Astrophys. J.; 160: 471-83(May 1970).

An energy principle is derived that gives a necessary and sufficient condition for the linear stability of inhomogeneous collisionless nonrelativistic stellar systems whose distribution function is a monotonic decreasing function of the energy. Although this energy principle is equivalent to several other variational principles, its derivation is made without any reference to normal modes or their completeness. This is regarded as a more satisfactory basis for the energy principle, since in general the normal modes are singular and form a continuous set whose completeness is difficult to treat. The energy principle is given in a different form which brings out the important role of constraints on the trial functions in giving a necessary condition for stability. The energy principle is applied to the case of an equilibrium with plane-parallel symmetry. It is shown that for any such slab equilibrium there exists a critical horizontal wavenumber such that all perturbations with larger horizontal wavenumbers are stable, but the slab is unstable to some perturbation at each of the smaller wavenumbers. This is an instability similar to the classical Jeans instability, but for a collisionless system rather than a fluid. (auth)

28050 A HIGH-RESOLUTION 5-GHz MAP OF 3C 33. Mitton, Simon (Cavendish Lab., Cambridge, Eng.). Astrophys. Lett.; 5: 207-11(May 1970).

The double radio galaxy 3C 33 was recently mapped at a frequency of 4.995 GHz with the One-Mile radio telescope at Cambridge; the resolving power was 6.5 arc sec (r.a.) by 19 arc sec (dec.). The source consists of two remarkably compact components separated from each other by about 50 times their diameters. The containment of these plasma clouds by the intergalactic medium is discussed. (auth)

28051 INTERFEROMETRIC STUDY OF IONIZED HYDROGEN IN THE LARGE MAGELLANIC CLOUD. Georgelin, Y.; Monnet, G. (Observatoire, Marseille). Astrophys. Lett.; 5: 213-18(May 1970).

First results obtained by Hα Perot−Fabry interferometry on H II regions in the Large Magellanic Cloud are presented. Evidence is given for a large disk of ionized hydrogen in the center, and its physical parameters are discussed. 240 radial velocities have been measured, and a preliminary rotation curve is given. (auth)

28052 PHOTOMETRY OF INTERGALACTIC MATTER IN THE COMA CLUSTER. De Vaucouleurs, G.; De Vaucouleurs, A. (Univ. of Texas, Austin). Astrophys. Lett.; 5: 219-26(May 1970).

The diffuse-light emission between galaxies has been measured in the central area of the Coma Cluster. Pulse-count photoelectric

scans with a 400-channel multiscaler covering 88 arc min in right ascension at the declination $\delta = +28° 15'$ (1950) of the brightest cluster member NGC 4889 show a detectable excess ($\mu < 29$ mag sec^{-2}) over an arc of 30 to 45 arc min centered at $\alpha = 12$ hr 57.3 min near the geometric center of the cluster; the peak intergalactic brightness is $\mu = 26.2$ mag sec^{-2}, and the integrated magnitude is $m_T(B) = 10.0 \pm 0.5$ or 40 % of the integrated luminosity of cluster galaxies as commonly defined. The observed "intergalactic" luminosity in the Coma cluster can be substantially accounted for by the overlapping coronas of the two supergiant members NGC 4874 and 4889 and a few others. The total magnitude of NGC 4889, including its corona, is $m_T(B) = 12.0 \pm 0.1$ with B–V = 1.1 and the total magnitude of the Coma Cluster within r = 100 arc min is $m_T(B) = 8.5$, with B–V = 1.0. If the distance is $\Delta = 63$ Mpc ($m - M = 34.2$), corresponding absolute magnitudes and luminosities are $M_T(B) = -22.2$, $M_T(V) = -23.2$ for NGC 4889 and $M_T(B) = -25.7$, $M_T(V) = -26.7$ for the whole cluster. (auth)

28053 PROPOSAL FOR AN X-RAY ANALYSIS OF INTERSTELLAR GRAINS. Martin, P. G.; Sciama, D. W. (Cambridge Univ., Eng.). Astrophys. Lett.; 5: 193-6(May 1970).

A method is proposed for detecting the presence of light elements in interstellar grains. The method depends on being able to observe around an x-ray source a halo arising from small-angle scattering by the grains. Near the K edges of elements in the grains this scattering is anomalous. The resulting effect on the intensity of the halo is estimated and shown to be appreciable in favorable cases. Brief reference is also made to K-edge absorption phenomena which are specific to elements in grains. (auth)

28054 VERIFICATION OF RADIO VARIABILITY OF THE GALAXY PKS 0048-09. Ross, H. N. (Univ. of Toronto). Nature (London); 226: 431(2 May 1970).

Observations have been reported that indicate variability in flux density of this galaxy at 8 GHz (Stull, Nature 225: 832(1970)). The present author made observations at several frequencies over practically the same period as Stull (Sept. 1968 to March 1970) using the 150 ft paraboloid of the Algonquin Radio Observatory. The frequencies used were 3.24, 6.63, and 10.63 GHz. The results of of these observations, together with those of Stull, are shown graphically. The 6.63-GHz points closely match the 8-GHz points of Stull, and verify the general character of the variability that Stull reported. The flux density appears to have increased with frequency in the 3- to 11-GHz range. The radio spectrum of the galaxy is also shown. There was still evidence of variability at the lower frequencies and no beam broadening was observed. (UK)

28055 THE BACKGROUND BRIGHTNESS OF THE MILKY WAY NEAR 2500 A BETWEEN $l'' = 72°$ and 126°. Sudbury, G. C. (Royal Observatory, Edinburgh); Ingham, M. F. Nature (London); 226: 526-8(9 May 1970).

Some sounding rocket data derived from four scans across the galactic plane between $l'' = 72$ and 126° at an effective wavelength of 2425 Å are discussed. These observations, while agreeing qualitatively with the ground-based observations, show certain details and quantitative aspects which may relate to the distribution of dust and stars and, when compared with other space observations, to the scattering and absorption properties of the interstellar dust in the ultraviolet. It is concluded that the spatial distribution of background light in the 2500 Å region and the Cygnus–Cassiopeia area suggests either that there is substantial light arising from relatively distant early-type stars which are some 150 pc above the galactic plane, or that there is a peak in the effective angular scattering function at some 10° to the galactic plane in this region. Comparison of the absolute values of the flux measured at 2500 Å with published data at 1400 Å suggests that there is a minimum in the interstellar dust albedo corresponding to the peak of extinction, unless there is some unpredicted source of excess flux at the shorter wavelength or near $l'' = 180°$. (auth) (UK)

Cosmology

28056 A GENERALISED HOYLE–NARLIKAR PARTICLE THEORY. McIntosh, C. B. G. (Univ. of New England, Armidale, New South Wales). Nature (London); 226: 339-40(25 Apr 1970).

A discussion is presented on the Hoyle–Narlikar particle (rather than field) theory of gravitation, which is based on Mach's principle that the mass (m_a) of a particle a arises from all other particles of the Universe (Proc. Roy. Soc. London, Ser. A, 282: 191(1964)). The mass depends on position, and the physical significance of the mass field is that $m_a(x)$ is the inertia contributed by the particle a to another at the point x. The inertial mass of a particle is equal to the inertia contributed to it by all the other particles. Particle equations closely related to Einstein's field equations then arise. The HN theory can be easily extended to allow for particles which contributed either positive or negative inertias, and the gravitational "constant" in the equations can be positive, negative, or infinite in different regions of space-time. An important and interesting result obtained is that both the Einstein and scalar–tensor field equations arise in special frames under a conformal mapping of the field equations. The HN particle equations are also important in that most of the particle and field equations normally used in relativistic-like theories can be derived from them. (UK)

28057 NEW PROBLEMS IN COSMOLOGY. von Reinhardt, Michael (Univ., Bonn). Naturwissenschaften; 56: 581-90(Dec 1969). (In German).

Problems of cosmology are discussed under two basic premises: physical laws, especially those related to conservation, are valid at every point of the space–time continuum; the general theory of relativity is the best existing approximation to a gravitation theory. Special emphasis is placed on the background microwave radiation and concepts of its origin. Both cold and hot models of the Universe are discussed with inclusion of corresponding nuclear processes. Formation of galaxies is considered. (142 references) (H.B.G.)

28058 MOST GENERAL FORM OF A FIELD THEORY FROM SYMMETRY PRINCIPLES. Sachs, M. (State Univ. of New York, Buffalo). Nature (London); 226: 138-9(11 Apr 1970).

The question discussed is stated to be: "What is the most general mathematical representation of a given theory that is based on a symmetry principle?". An attempt is made to answer this in terms of the theory of relativity. It is contended that the most general field representation of any theory of symmetry, and in particular the theory of relativity, is in terms of field variables that solve a set of equations the number of which is equal to the number of essential parameters that characterise the symmetry group. Arguments for this contention are put forward, both in terms of general and special relativity, and in relation to gravitation and electromagnetism. It is concluded that it may be interesting to apply the proposed contentions to other branches of physics. (UK)

28059 COSMIC BACKGROUND OF LOW-ENERGY NEUTRINOS. DeGraaf, T. (Univ., Groningen, Netherlands). Astron. Astrophys.; 5: 335-40(May 1970).

Concepts that have been proposed concerning a cosmic background of low-energy neutrinos are reviewed. Because of the fact that these particles have only weak interactions with other particles, it is very hard to detect such a background. One can find an upper limit for the energy density of these neutrinos from cosmological considerations, comparison with the density of the photon black-body radiation and experimental data concerning beta decay and the cosmic-ray spectrum. A new value for this upper limit was found from recent results for the beta-decay spectrum, and the scattering process between neutrinos and nucleons, for which new experimental data and theoretical ideas have been given recently, is considered. From the cross section for the scattering of neutrinos with nucleons a mean free path is obtained for the protons in cosmic rays that pass through a degenerate Fermi gas of neutrinos. Experimental data for the spectrum of cosmic rays at ultrahigh energies and assumptions about their origin provide other possible values of the upper limit for the neutrino density. (auth)

28060 POSSIBLE VERIFICATION OF SOME COSMOLOGIC MODELS. Kalinkov, Marin. Izv. Sekts. Astron., Bulg. Akad. Nauk.; 3: 99-104(1969). (In Russian).

The idea of observational verification of some cosmologic models, which is possible in the examination of a discretization effect in quasars is proposed. A verification for three cosmologic models is carried out with the aid of the redshifts for 77 quasars. Following the observational data, it is shown that one of the models with $q_0 = 1$, $\delta_0 = 0$ ($K = -1$, $\Lambda < 0$) should be accepted with greater probability. (Abstr. Bulg. Sci. Lit.)

28061 NUCLEAR REACTIONS AND ELEMENTARY-PARTICLE REACTIONS IN A COLD UNIVERSE. Kaufman, Michele (Brown Univ., Providence). Astrophys. J.; 160: 459-70(May 1970).

Effects of nuclear reactions and elementary-particle reactions are investigated in a Friedmann Universe in which the lepton abundance is positive and electrons are either completely or partially degenerate at nuclear density. Semiquantitative arguments suggest that the energy liberated by hyperon–meson decay would be sufficient eventually to remove nucleon degeneracy, but not electron degeneracy, in a Universe that was initially completely degenerate. Only a modest abundance of electron-type neutrinos is required to reduce the prestellar helium concentration to a level consistent with observations. If the ratio of the cosmic temperature to the electron degeneracy temperature is

less than 0.15 initially, one obtains negligible prestellar helium with a present neutrino Fermi level of 3×10^{-4} eV. At such low initial temperatures, nuclear energy liberated in forming prestellar helium is released too early in the expansion to remove electron degeneracy. (auth)

28062 PRODUCTION OF HELIUM IN THE BIG-BANG EXPANSION OF A MAGNETIC UNIVERSE. Matese, J. J.; O'Connell, R. F. (Louisiana State Univ., Baton Rouge). Astrophys. J.; 160: 451-8(May 1970).

The effects of a magnetic field on the reaction rates for the processes $n + e^+ \rightleftharpoons p + \bar{\nu}$, $n + \bar{\nu} \rightleftharpoons p + e^-$, and $n \rightleftharpoons p + e^- + \bar{\nu}$ are calculated. The implications for the production of helium in the big-bang expansion of a magnetic Universe are discussed. The influence of a magnetic field on the expansion rate of the Universe is also considered, and it is found that its effect on the rate of helium production dominates over the effects arising from the changed reaction rates. (auth)

28063 COSMIC SOURCES OF INFRARED RADIATION. Burbidge, G. R. (Univ. of California, San Diego); Stein, W. A. Astrophys. J.; 160: 573-93(May 1970).

The physics of radiation processes is applied to an analysis of the observations of infrared sources. It is shown that in the case of most galactic infrared sources small mass fractions (10^{-4} to 10^{-6} $M_\odot$) of solid particles surrounding luminous stars can explain the data. In the case of η Car, the much larger mass (0.08 $M_\odot$) required in solid particles and gas leads to the conclusion that the energy source in this object is a very massive ($\sim 10^2$ $M_\odot$) unstable star. An analysis is made of the observations of the galactic center, but it does not seem possible at this time to decide whether the infrared radiation is due to nonthermal processes or an energy source surrounded by dust. Calculations applied to the dust hypothesis of the origin of infrared radiation in the nuclei of Seyfert galaxies and quasi-stellar objects lead to results that appear difficult to reconcile with infrared and optical observations. This is because the size limits set by the variations detected in NGC 1068 and NGC 4151 are incompatible with the calculated sizes of the dust clouds required to give the observed fluxes. Also, the compositions of the dust clouds would have to be abnormally rich in carbon and heavier elements out of which dust is formed. It is shown that the synchrotron models are able to explain the infrared flux from the nuclei of galaxies, provided that the magnetic field strengths are ~1 to 100 gauss. Nuclei made up of a number of small components are indicated in some cases. (auth)

28064 ORIGIN OF MAGNETIC FIELDS. Parker, E. N. (Univ. of Chicago). Astrophys. J.; 160: 383-404(May 1970).

The present understanding of the origin of magnetic fields is reviewed. Topics considered include the basic equations, the role of primordial fields, generation of fields by fluid motions, generation of fields by ordered fluid motions, and solar and stellar magnetic fields. (W.D.M.)

28065 HALF-CLOSED SPACES IN RELATIVISTIC ASTROPHYSICS. Zieba, Andrzej. Postepy Astron.; 18: 101-7(Jan-Mar 1970). (In Polish).

A short survey is given of basic properties of equations of general relativity theory solutions. The solutions of Schwarzschild and Friedmann, as well as a combination of these two solutions are used to describe the so-called half-closed spaces. (auth)

28066 OSCILLATORY APPROACH TO SINGULAR POINT IN THE OPEN COSMOLOGICAL MODEL. Lifshitz, E. M.; Khalatnikov, I. M. (Inst. of Physics Problems, Moscow. Inst. of Theoretical Physics, Moscow). JETP Lett. (USSR)(Engl. Transl.); 11: 123-5(5 Feb 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 200-3 (5 Feb 1970).

It has been shown in earlier communications that, in the general cosmological solution of Einstein's equation, there exists a singularity having a complicated oscillatory character. A particular example of a homogeneous closed model (a world with homogeneous space of Type IX after Bianchi) was also considered, which admits of a more complete analysis. Another similar example is reported, which not only confirms the qualitative analysis of the general case, but casts additional light on certain aspects of the problem. The model with homogeneous space of Type VIII after Bianchi is considered. (W.D.M.)

28067 TURBULENCE IN THE HOT UNIVERSE. Chernin, A. D. (Ioffe Physico-Technical Inst., Leningrad). Nature (London); 226: 440-1(2 May 1970).

The development of Von Weizsaecker's cosmogonical hypothesis (Astrophys. J., 114: 165(1951)) led to studies on the combined hydrodynamical motions of the photon gas and the cosmic plasma in the early "hot" Universe, when the radiation density greatly exceeded the density of matter. In the case of vortex motions the initial stage of cosmological expansion is non-Friedmannian with anisotropic and inhomogeneous geometry; but there is speculation in favor of the motion having a potential character, and in this case the departures from the Friedmann model are small at all epochs, from the general theory. The hydrodynamical aspects of the evolution of the cosmic fluid at the matter-dominated stage are considered in the present communication, assuming cosmological expansion to be described by an open Friedmann model, an assumption based on a number of observational and theoretical arguments. The matter-dominated stage occurs when the temperature drops below ≈3,000°K. Protons and electrons combine under these conditions, and matter is decoupled from radiation provided the medium is in thermal equilibrium and not perturbed. The situation can, however, be quite different when there are hydrodynamical motions that heat the matter; heating can maintain sufficient ionization for the dynamical interaction of matter with radiation. The analysis presented indicates evolution of the cosmic fluid from a remote past, when motions might be excited as small perturbations, up to the stage of compressible turbulence with adequate characteristics for galaxy formation. An explanation of how the initial motions originated is not arrived at, but the primitive dynamical structure is probably an integral part of the Universe from the earliest times, like its general expansion. (UK)

28068 EQUATION OF STATE OF MATTER AT ULTRAHIGH DENSITIES. Chanmugam, G. (Brandeis Univ., Waltham, Mass.). J. Phys., A (London); 3: L19-21(May 1970).

It is shown that Zeldovich's results for the behavior of matter at ultra-high densities are not valid when many-body forces are included. (auth) (UK)

Planetary Phenomena

Refer also to abstract 27477.

28069 (ORNL-TM-2869) THERMALLY STIMULATED EXOELECTRON EMISSION FROM TERRESTRIAL AND LUNAR MINERALS. Becker, Klaus (Oak Ridge National Lab., Tenn.). Feb 1970. Contract W-7405-eng-26. 19p. Dep. CFSTI.

Preliminary results on the release of low-energy electrons from the surface of several unirradiated and preirradiated terrestrial minerals (dunite, andesite, granodiorite, granite, and basalt) and from lunar soil (10065-20) during linear heating inside a gas-flow GM counter are reported. A pronounced emission peak, at ~495°C, was observed only in granodiorite before irradiation. After exposure to a high gamma radiation dose, several peaks at temperatures between ~140 and ~500°C were observed in some of the terrestrial minerals, and peaks at ~150°C, ~275°C and ~475°C in the lunar material at a heating rate of 2°C/sec. Some preliminary experiments on the dose response and the heating rate dependence of the peak locations were carried out, and possible implications for further studies are discussed. (auth)

28070 LUNAR DUST. Runcorn, S. K. (Univ. of Newcastle, Australia). Sci. J.; 6: No. 5, 27-33(May 1970).

The results of the studies of the rocks brought back through the Apollo 11 landing are described. A series of simple inorganic compounds—carbon monoxide, carbon dioxide, and methane—were found, together with some compounds of higher molecular weight, such as glycine, alanine, and urea. The most likely source of lunar carbon seems to be either the solar wind or from outgassing of the material from which the Moon is made. No form of life was found. The age of the lunar rocks and the general nature of the surface crust are discussed. Three new minerals were found. The mechanical, electrical, and magnetic properties of the lunar rocks were considered. Three theories concerning the origin of the Moon are discussed in relation to the data obtained from the Apollo 11 landing. (UK)

Atomic and Molecular Physics

Refer also to abstracts 27231 and 27325.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 28468 and 28812.

28071 (ORO-3557-10) PROTON SPUTTERING. Fourth Annual Progress Report, June 1, 1969-February 28, 1970. Finfgeld, Charles R. (Roanoke Coll., Salem, Va. Dept. of Physics). Mar 1970. Contract AT(40-1)-3557. 7p. Dep. CFSTI.

The results of a study of wall erosion in controlled thermonuclear fusion devices are briefly summarized. Experiments on the

sputtering isotope effect, using He^+ ions on ruthenium, are described; results are inconclusive. An experiment on electron sputtering of beryllium is in progress. (D.L.C.)

28072 BACKSCATTER CURRENTS FROM THIN Ag FILMS UNDER BOMBARDMENT BY ATOMIC PROJECTILES. van Wijngaarden, A. (Univ. of Windsor, Ont.); Miremadi, B.; Brimner, E. J.; Bradford, J. N. Can. J. Phys.; 48: 1026-35(1 May 1970).

Thin Ag films formed by vacuum deposition on a low-Z backing material were irradiated by keV ion beams of ^1H, ^{14}N, and ^{40}Ar. The backscatter current yield was measured with a collector plate, kept at a negative potential. For ^1H, the backscatter yield increases rapidly with film thickness while for ^{40}Ar projectiles, the yield arises mainly from a thin surface layer. The maximum depth contributing to the backscatter current yield is of the same order as the projected range in the target material. Arguments are presented that the depths involved in backscatter currents and in sputtering will be of comparable importance. (auth)

28073 THEORY OF IONIZATION LOSSES OF FAST ELECTRONS. I. Dolgov, A. S.; Khizhnyak, N. A. (Kharkov Aviation Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 9, 153-5(1969). (In Russian).

The problem of fast electron energy losses was studied, taking into account the relationship between the energy-transfer cross section and the energy-loss magnitude. Results were in good agreement with published data, considering that the effect studied was mostly considered for the case of nonrelativistic velocities. (R.V.J.)

28074 SECONDARY-ELECTRON ENERGY DISTRIBUTION STUDIES OF UO_2 SURFACES. Ellis, W. P.; Campbell, B. D. (Los Alamos Scientific Lab., N. Mex.). J. Appl. Phys.; 41: 1858-61(15 Mar 1970).

Excitation thresholds were determined for the Auger transitions as an aid in detecting impurities where U interferes. Carbon can be detected on U compounds by exciting the transition at E_p = 500 eV. Variation in E_p also permits a determination of the ionized level responsible for a given Auger peak. UO_2 (110) Auger spectrum is tabulated, along with the ionization characteristic losses. Correlation of the ionization losses with the Auger spectrum is discussed. (D.L.C.)

28075 AVERAGE RELATIVE ENERGY OF ELECTRONS BACKSCATTERED FROM A MASSIVE TARGET. Vincensini, Paul-Dominique (Centre National de la Recherche Scientifique, Toulouse). Compt. Rend., Ser. B; 270: 761-4(16 Mar 1970). (In French).

A method is proposed to calculate the average relative energy of electrons backscattered from a massive material target bombarded with a parallel beam of monoenergetic electrons. (France)

28076 INVESTIGATION OF THE PROCESS OF RESONANT CHARGE EXCHANGE IN THE He^+–He SYSTEM. Latypov, Z. Z.; Fedorenko, N. V.; Flaks, I. P.; Shaporenko, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 11: 116-18(5 Feb 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 189-91(5 Feb 1970).

The cross section of the process $He^+ + He \rightarrow He + He^+$ was measured at energies of 150 to 3200 eV. The resulting curve is nonmonotonic, having an oscillating character. The relation of the resonant charge exchange to the odd and even states of He is discussed. (D.L.C.)

Atomic and Molecular Properties

Refer also to abstracts 28456, 28580, and 28589.

28077 (ANL-7615, pp 209-13) FORM FACTORS OF H^-, He, AND Li^+. Kim, Y.-K. (Argonne National Lab., Ill.).

Atomic form factors and incoherent scattering functions are necessary in evaluating the cross sections for the coherent and incoherent scattering of photons as well as those for the elastic and inelastic scattering of charged particles by atoms and molecules. Accurate atomic form factors, incoherent scattering functions, and the Born elastic electron scattering factors for the ground states of H^-, He, and Li^+ were computed from correlated wave functions. The data presented are in good agreement with those evaluated from less accurate wave functions, and confirm the expectation that the electron correlation affects the values of incoherent scattering functions more than those of atomic form factors. Values of some integrals used in the sum rule for the Bethe cross sections are also tabulated. (auth)

28078 RESONANCE BROADENING USING GREEN FUNCTIONS. Manassah, J. T.; Foley, H. M. (Columbia Univ., New York). Phys. Lett.; 31A: 265-6(9 Mar 1970).

The fundamental theory of line broadening is studied as a many-body problem by Green-function formalism. Some general properties of asymmetry and asymptotic behavior are deduced from general arguments. An application is made to the resonance broadening of 7281 Å of He and good agreement is obtained with Kuhn's precise experimental value. The observed residual widths at zero density for He, Ne, and Kr are also accounted for as an emission–reabsorption process. (auth)

28079 RELATIVE X-RAY TRANSITION PROBABILITIES TO THE K-SHELL. Hansen, J. S.; Freund, H. U.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Nucl. Phys., A142: 604-8 (1970).

Accurate measurements over an extended range in Z were made of the major K x-ray groups. Errors due to scattering and fluorescent excitation were minimized by the use of carrier-free radioactive sources mounted on thin Mylar films, resulting in very high peak-to-continuum ratios. The measurements of K_β/K_α, $K_\alpha/K_{\alpha 1}$, $K_{\beta' 1}/K_{\alpha 1}$ and $K_{\beta' 2}/K_{\alpha 1}$ x-ray intensity ratios were carried out to approximately 2% accuracy. For $Z \geq 38$, a high-resolution Ge(Li) x-ray detector (460 eV fwhm at 6.4 keV) was used; at low Z, a Si(Li) x-ray detector (260 eV fwhm at 6.4 keV and a 0.05-mm Be window) was used. The low-energy efficiency of each detector was evaluated with corrections applied for deadlayer absorptions, K x-ray escape, energy-dependent geometry, and detector shape and mounting. The results are compared with recent relativistic theoretical calculations by Scofield. (auth)

28080 EXPERIMENTAL EVIDENCE OF OPTICAL EXCITATION OF 4f ELECTRONS IN Yb. Broden, G.; Hagstroem, S. B. M.; Norris, C. (Chalmers Univ. of Tech., Goteborg). Phys. Rev. Lett.; 24: 1173-4(25 May 1970).

Uv photoemission measurements on evaporated films of Yb are reported. The results locate the spin–orbit–split 4f states at 1.20 and 2.50 eV below the Fermi level. (auth)

28081 $K\beta_2/K\beta_1$ TRANSITION PROBABILITIES IN ELEMENTS OF MEDIUM AND HIGH ATOMIC NUMBER. Salem, S. I.; Saunders, B. G.; Nelson, G. C. (Univ. of California, Livermore). Phys. Rev., A; 1: 1563-6(Jun 1970).

The $K\beta_2/K\beta_1$ transition probabilities were measured for the following elements: In, Sn, Te, Ce, Tb, Ta, Re, Au, Pb, Th, U, Np, Pu, and Am. This was accomplished using a spectrometer with a bent quartz crystal in conjunction with a Ge(Li) detector. The measured transition probabilities for elements of medium atomic numbers are in good agreement with calculations based on the relativistic Hartree–Slater potential, while in the region of high atomic number the measured values seem to favor theoretical values obtained assuming a Coulomb potential with the electron screening effect prescribed by Burns. (auth)

28082 PRESSURE-BROADENED LINEWIDTHS IN THE ELECTRIC-FIELD-INDUCED SPECTRUM OF H_2. Hunt, R. H. (Florida State Univ., Tallahassee); Barnes, W. L.; Brannon, P. J. Phys. Rev., A; 1: 1570-4(Jun 1970).

The linewidths of Q(0) to Q(4) in the electric-field-induced fundamental band of H_2 were measured with 0.027-cm^{-1} resolution for pressures between 4.4 and 35 atm. The widths were found to vary linearly with density, with negligible contributions from the Doppler effect because of collision narrowing. The values obtained for the broadening coefficients at 300°K are, in order of increasing J: 2.78, 1.83, 3.05, 4.60, and 3.26 in units of 10^{-3} cm^{-1}/amagat. These values are 20 to 30% larger than previous results from Raman data. The linewidth calculations of Van Kranendonk are revised to include the effective rotational constants of H_2, and the results are compared with experiment. The agreement is fair when the anomalously small calculated width for Q(1) is excluded. (auth)

28083 DISSOCIATION OF THE HYDROGEN MOLECULE–ION FROM THE VIEWPOINT OF THE INTEGRAL HELLMANN–FEYNMAN FORMULA. Marron, Michael T.; Parr, Robert G. (Johns Hopkins Univ., Baltimore). J. Chem. Phys.; 52: 2109-27(15 Feb 1970).

The dissociation energy of the hydrogen molecular ion is computed and analyzed by means of the integral Hellmann–Feynman theorem. The molecule is considered to dissociate either symmetrically by the removal of one of the nuclei to infinity or symmetrically by the simultaneous removal of both nuclei to infinity. The energy change is computed for each path and compared with the difference of the energy expectation values for the initial and final states. The Hellman–Feynman results are in general different for the two paths, while the differences of expectation values are not. The final separated-atom state is represented by the exact wave function. The initial state is represented by a variety of wave functions including variational functions in both AO bases and elliptic MO bases, wave functions with cor-

rect cusp behavior forces, wave functions that approximate correct long-range behavior, and wave functions formed from a linear combination of initial-state functions and final-state functions. A dissociation process wherein the nuclear charge increases upon dissociation is also examined. The integral Hellmann–Feynman method produces a 0/0 indeterminacy for symmetric dissolution, which is resolved by a limiting procedure. The integral Hellman–Feynman approach involves the construct of transition density, which contains information about reorganization of electronic distribution from the initial to the final state, and which permits the dissociation energy to be expressed as the sum of the nuclear–nuclear repulsion energy and the classical electrostatic attraction energy of the nuclei for the transition density. Contour plots of the transition densities along the internuclear axis are given. (auth)

28084 RANGE RELAXATION. IV. OPTIMAL SERIES EXPANSION COEFFICIENTS FOR MOLECULAR POTENTIAL CURVES AND SURFACES. Empedocles, Philip (Univ. of California, Berkeley). J. Chem. Phys.; 52: 1703-12(15 Feb 1970).

A simple many-dimensional (multiple) perturbation-variation scheme is invoked to generate the coefficients in the expansion of an energy curve or surface about some origin, to arbitrary small order. These expressions appear in a form in which it is unnecessary to start with a full set of eigenvectors and eigenvalues of the Hamiltonian. This permits their use in conjunction with large-scale configuration-interaction calculations. The relaxation of both linear and nonlinear parameters in the wave function from their values at the origin is taken into account. The expansion can be used as a basis for the development of both range and pass relaxation functions. The approach abridges the more conventional two-step procedure of calculating the energy at a set of points that must subsequently be fitted to a polynomial. It eliminates thereby the repeated laborious solution of the eigenvalue problem. For the particular case of a one-dimensional coordinate representing a uniform scaling of the nuclear positions it is trivially easy to generate matrix-element derivatives by scaling. In application to several small molecules using a Gaussian-type basis in both SCF–MO and CI frameworks such simple scaled matrix elements are shown to provide a reasonably good basis over a useful range of coordinates. In the particular case of a 20-configuration wave function for H_2^+ the scaled and conventional curves are particularly indistinguishable over a range 0.25 to 15.0 a.u. The results are reproduced over a more limited section of the curve using the perturbation expansion in the inverse of the internuclear distance. (auth)

28085 PHOTODISSOCIATION OF H_2 NEAR THRESHOLD ENERGIES. Comes, F. J.; Wenning, U. (Univ., Bonn). Z. Naturforsch.; 25a: 237-42(Feb 1970).

Measurements of the atomic hydrogen fluorescence (Ly_α) yield important information on the dissociation behavior of molecular hydrogen under photon impact. Under certain assumptions the dissociation cross section of the molecule can be deduced from such experiments. By applying an appropriate electric field in the observation region, those dissociations leading to the formation of metastable hydrogen atoms can be quantitatively determined. This information opens the possibility to describe the predissociation of the excited H_2 molecules in the C, D and B′ states. The experiments show that the excited molecules in these particular states dissociate into H(1S) and H(2S) by configuration interaction with the B′ state. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

28086 SIMPLE CORRELATED WAVE FUNCTIONS FOR POSITRONIUM NEGATIVE ION $e^-e^+e^-$. Ferrante, G.; Geracitano, R. (Univ., Messina, Italy). Lett. Nuovo Cim.; 3: 48-50 (8 Jan 1970).

The construction of a simple analytical wave function for $e^-e^+e^-$ is described briefly. Parameter values, normalization constants, and ground-state energy values calculated using various forms of the correlation function are tabulated. Results agree reasonably well with those obtained using more complex functions. (A.G.W.)

28087 FORMATION OF POSITRONIUM IN 1S AND 2S STATES IN OXIDES. Gol'danskii, V. I.; Levin, B. M.; Mokrushin, A. D. (Inst. of Chemical Physics, Moscow). JETP Lett. (USSR)(Engl. Transl.); 11: 23-6(5 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu; 11: 38-42(5 Jan 1970).

The correlation between positronium formation and the width of the forbidden band (E_g) of some oxides is pointed out: intense positronium is formed in oxides whose E_g exceeds 6.8 eV, the binding energy of the positron–atom ground state in vacuum. This correlation is confirmed by measurements on B_2O_3 (E_g = 9.0 eV) and HgO (E_g = 1.0 – 1.2 eV); an intense long-lived component with $\tau_2 = 1.7 \times 10^{-9}$ sec was observed for B_2O_3, but none at all for HgO. A criteron for positronium formation is written; for positronium in the 1S state, $E_g \geq 6.8$ eV, while for the 2S state, $E_g \geq 1.7$ eV. The possibility of looking for the 2S state is discussed, and some indirect evidence for such a state in HgO, La_2O_3, and Sb_2O_5 is given. (D.L.C.)

28088 SECOND-ORDER CALCULATIONS OF THE SINGLE-QUANTUM ANNIHILATION CROSS SECTIONS IN VARIOUS ATOMIC SHELLS. Morol, David S.; Davidz, Andreas; Kess, Rudolph F. (Kent State Univ., Ohio). Phys. Rev., A; 1: 1647-54(Jun 1970).

A general method for calculating the cross sections for single-quantum annihilation (SQA) of positrons in various atomic shells, valid to second order in the αZ expansion (one order beyond the leading term), is presented with the help of the modified Sommerfeld–Maue wave function for incoming positrons and the relativistic wave functions for the bound electrons in any atomic shells. It is shown in this approximation that the differential cross sections are of the form $\sigma_{n_0 f}(k,q) = C_{n_0 i}\sigma_{n_0 f i}(k,q)$, where $n_0 = l + 1$, and k and q are the photon energy and the magnitude of momentum transfer to a nucleus, respectively. The factor $C_{n_0 i}$ is evaluated in general. The SQA cross sections are calculated for the $1s_{\frac{1}{2}}$, $2p_{\frac{1}{2}}$, and $2p_{\frac{3}{2}}$ states to 2nd order in the αZ expansion and for the $3d_{\frac{3}{2}}$ and $3d_{\frac{5}{2}}$ states to lowest order in the αZ expansion, and are in closed form. The relationship between the SQA cross section for any state and the corresponding cross section for the atomic photoeffect is discussed. The leading term for the SQA cross section is closely related to that for the photoeffect, but there is a distinct difference between the correction terms for the former and the latter. The comparison of the results of the present work for the K and L_1 shells with a recent numerical calculation done by others shows that for low and intermediate energies, the above factorization rule is valid within 1.4% for Z = 47 and 3.8% for Z = 90. However, the $1s_{\frac{1}{2}}$ cross section for $Z \geq 82$ is negative for any energy below 2.264 MeV. (auth)

Collision Phenomena

Refer also to abstracts 27331, 28625, 28633, and 28818.

28089 (ANL-7615, pp 207-9) INELASTIC-SCATTERING CROSS SECTIONS OF FAST CHARGED PARTICLES BY Li^+. Kim, Y.-K.; Inokuti, Mitio (Argonne National Lab., Ill.).

The cross sections for some important discrete excitations and for the total inelastic scattering of fast charged particles by Li^+ are evaluated directly from correlated wave functions and other data in the literature according to the Bethe procedure and related sum rules. Cross sections for other discrete excitations are determined by extrapolating their dependence on the effective quantum numbers. The ionization cross section is then obtained by subtracting the sum of all discrete excitation cross sections from the total inelastic scattering cross section, thus avoiding the direct use of any continuum wave functions. The resulting ionization cross section is reliable, and agrees very well with the experiment by Peart and Dolder. (auth)

28090 (ANL-7615, pp 213-14) NUMBER OF BOUND STATES IN ION–ATOM SYSTEMS. Tani, Smio; Inokuti, Mitio (Argonne National Lab., Ill.).

The knowledge of the number of bound states and density of states of a molecular ion is very useful in the analysis of molecular spectra and also in the study of ion–atom scattering at low incident energy. The WKB approximation in quantum mechanics will be used to estimate the total number of bound states and the density of states for the ion–atom complex represented by a simple parameter. (auth)

28091 (ANL-7615, pp 214-18) SPECIFIC PRIMARY IONIZATION. Rieke, F. F.; Prepejchal, William (Argonne National Lab., Ill.).

Primary ionization in 16 additional gases was studied. Present and previous results are summarized in graphical form. New measurements show that high-energy positrons and electrons have primary ionization cross sections that are equal within one percent. (auth)

28092 (NP-18235) MULTIPHOTON IONIZATION OF ATOMS. Preprint No. 11. Delone, N. B.; Keldysh, L. V. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1970. 38p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The recently discovered new process leading to the ionization of atoms by an electromagnetic field, the multiphoton ionization,

is reviewed. In this case, ionization occurs as the result of the absorption of photons by atomic electrons; the energy of these photons is much lower than the ionization potential of the atom. The required high-intensity monochromatic radiation may be obtained only by the use of lasers. The process was first observed in 1965 by one of the authors in the case of the ionization of xenon atoms and hydrogen molecules by the radiation emitted by a ruby laser. The strong radiation field needed to observe the effect not only induces electron transitions from one stage to another but also changes these states. The probability of the multiphoton ionization of an atom depends on the type of polarization of the radiation and the ellipticity of the system. The theoretical explanation is based on the higher-order perturbation theory, or on the resonance excitation of an intermediate level. The experimental work requires either a high field voltage or a high specificity of the individual ionization related to the absorption processes. (32 references) (TTT)

28093 CHARGE EXCHANGE COLLISIONS BETWEEN HYDROGEN IONS AND ALKALI VAPOR IN THE ENERGY RANGE OF 1 TO 20 keV. Gruebler, W.; Schmelzbach, P. A.; Koenig, V.; Marmier, P. (Eidgenoessische Technische Hochschule, Zurich). Helv. Phys. Acta; 43: 254-71(15 May 1970).

Charge-exchange collisions were studies for H^+ and D^+ ions incident on the alkali vapors Cs, K, Na, and Li. Measurements of the positive and negative beam components after passage through the target were made in the energy range of 1 to 20 keV. Also the one- and two-electron charge-exchange cross sections σ_{10} and σ_{1-1} were determined in this energy range. The value of the maximum of the negative beam component decreases monotonically from approximately 20% of the incident beam intensity at about 1 keV for Cs to 6% at 4 keV for Li. The maxima of Cs and K are quite sharp, whereas the maxima of Na and Li show a much broader behavior, such that, for the latter elements, the yield at 10 keV is higher by a factor 2 to 5. The maximum of the cross section σ_{10} for all the elements measured is approximately 10^{-14} cm^2. The cross section σ_{1-1} has the maximum value of 8×10^{-17} cm^2 for Li, 5×10^{-16} cm^2 for Na, 6×10^{-17} cm^2 for K, and 6×10^{-17} cm^2 for Cs. An analysis of the results shows that the adiabatic parameter postulated by Massey is dependent on the nature of the colliding particles. (auth)

28094 SCATTERING OF CHARGED PARTICLES BY HELIUM ATOMS. Franco, Victor (Brooklyn Coll., N. Y. Los Alamos Scientific Lab., N. Mex.). Phys. Rev., A; 1: 1705-8(Jun 1970).

Elastic and inelastic scattering of charged particles by helium atoms is analyzed in the Glauber approximation. Applications are made to the differential cross sections for electron–helium elastic scattering, and the predictions are compared with the first Born approximation and with measurements between 100 and 500 eV. At small momentum transfers the calculated intensities for elastic scattering are significantly greater than those obtained from the Born approximation. (auth)

28095 GLAUBER THEORY OF ATOMIC-HYDROGEN EXCITATION BY ELECTRON IMPACT. Tai, H. (Univ. of Pittsburgh); Bassel, R. H.; Gerjuoy, E.; Franco, Victor. Phys. Rev., A; 1: 1819-35(Jun 1970).

The Glauber approximation was applied to excitation of the 2s, 2p, 3s, and 3p levels of the hydrogen atom by electron impact. The differential and integrated excitation cross sections predicted by the Glauber theory were compared with experiment and with other calculations. The Glauber approximation is a considerable improvement over the Born approximation at energies $\lesssim$100 eV. At energies $\gtrsim$100 eV, the Glauber total excitation cross sections approach the Born approximation, even though at large scattering angles (>40°) the Glauber differential cross sections may be very different from the Born approximation. At intermediate energies (~30 to 100 eV), the Glauber predictions are surprisingly good; at energies $\lesssim$20 eV, the Glauber integrated cross sections are smaller than those observed experimentally. (auth)

28096 POTENTIALS FOR HIGH-ENERGY SCATTERING FROM HYDROGEN-LIKE ATOMS. Reading, J. F. (Northeastern Univ., Boston). Phys. Rev., A; 1: 1642-7(Jun 1970).

The time-dependent equation $[i\hbar v\partial\varphi(r,R)/\partial Z] = \exp(iH_eZ/\hbar v)\, V(r,R) \exp(-iH_eZ/\hbar v)\, \varphi(r,R)$, $t = Z/v$ describing a fast particle perturbing a bound system was solved by Glauber in the diabatic approximation of setting H_e equal to zero. The nonlocal potential $\exp(iH_eZ/\hbar v)\, V(r,R) \times \exp(-iH_eZ/\hbar v)$ is thus approximated by a local or diagonal form $V(r,R)$. In this paper the local approximation is retained. The bound system is assumed to consist of a single electron attached to a fixed point with wave function $\exp(-r/a_0)$. It is then shown how the diabatic approximation can be relaxed by modifying V to include the effect of H_e to order v^{-1}. In particular, in the impulse approximation, scattering is described by a static local potential $V_L(r,R) = 1/R - [\mathrm{erf}(i^{\frac{1}{2}}\alpha + \epsilon)]/|\vec{R} - \vec{r}|$, where $\alpha^2 = |\vec{R} - \vec{r}|^2/(2cZ)$, and $c = \hbar/(mva_0)$ An analytic form is given for $\varphi(r; \vec{B}, \infty)$. The binding of the electron neglected in the impulse approximation can be taken into account by changing V_L to $V_L(r + x, R)$, where $x = e^{icZ} - 1$. The scattering problem is thus reduced to quadratures. (auth)

28097 MOLECULAR-ORBITAL CALCULATION OF THE SHAPE RESONANCE IN N_2^-. Krauss, M.; Mies, F. H. (National Bureau of Standards, Washington, D. C.). Phys. Rev., A; 1: 1592-8(Jun 1970).

The 2-eV shape resonance in N_2–electron scattering is calculated by a self-consistent-field energy-variational procedure. The resonance state corresponds to the attachment of an incident d-wave electron to the $1\pi_g$ valence orbital of the metastable $^2\Pi_g$ state of N_2^-. The resonant behavior is due to the tunnelling of the electron through a $2(2 + 1)/r^2$ centrifugal barrier and temporary trapping in an attractive field. This tunnelling is reflected in the bimodal behavior of the calculated $1\pi_g$ orbitals; the inner portion of the orbital defines the resonance state. The "potential" curve for N_2^- is calculated in the Hartree–Fock approximation; a resonance threshold of 2.5 eV is predicted, with $R_e = 2.27$ a.u. and $\omega_e \approx 2000$ cm^{-1}. Expected correlation-energy corrections would improve the agreement with experiment. A local potential for electron scattering is generated by inverting the $1\pi_g$ orbital, and resonance widths are calculated. The widths vary from 0.13 eV at the equilibrium distance of N_2^- to 0.8 eV at the N_2 equilibrium distance. (auth)

28098 SIMULTANEOUS EXCITATION AND IONIZATION OF ARGON BY ELECTRONS TO THE UPPER LASER STATES OF Ar^+. Latimer, I. D.; St. John, R. M. (Univ. of Oklahoma, Norman). Phys. Rev., A; 1: 1612-15(Jun 1970).

Experimental cross sections for the simultaneous excitation and ionization of argon to the 4p configuration of Ar^+ are presented. The data are found to be in considerable disagreement with previous work. Optical excitation functions for the important argon–ion laser lines are given, and the results are compared with the observed relative gains of the lines in a pulsed laser. The cross sections for excitation to the 4p ^2P states of Ar^+ are found to have an E^{-1} dependence with energy in the range 250 to 700 eV, in disagreement with the asymptotic behavior predicted from the sudden approximation. (auth)

28099 ABSOLUTE FLUORESCENCE YIELDS OF 3914-A PHOTONS FROM N_2 AND AIR EXCITED BY RELATIVISTIC ELECTRONS. Hirsh, M. N.; Poss, E.; Eisner, P. N. (Dewey Electronics Corp., New York). Phys. Rev., A; 1: 1615-26 (Jun 1970).

The absolute fluorescence intensity of the first negative (0,0) band of N_2^+ at 3914 Å excited by bombardment of N_2 and N_2:O_2 mixtures with electrons in the previously unstudied energy range 0.65 to 1.6 MeV was measured at gas pressures of 0.05 to 8 torr. An effective cross section for the production of these photons by 1.5-MeV primary electrons and all secondary electrons resulting from the ionization events is found to be $(1.6 \pm 0.4) \times 10^{-19}$ cm^2. The measurements indicate that 10% of the N_2^+ ions are formed in the $B^2\Sigma_u^+(v' = 0)$ state and that the fluorescence efficiency for the 3914-Å band is $(6.0 \pm 1.9) \times 10^{-3}$ for N_2 and $(4.8 \times 1.5) \times 10^{-3}$ for air, in agreement with modern results at lower energies. From comparison with recent published results of primary excitation at lower energies, it appears that $\frac{2}{3}$ of the observed photons are produced by secondary electrons. Quenching cross sections for the $B^2\Sigma_u^+(v' = 0)$ state of N_2^+ in collisions with ground-state neutral molecules of N_2 and O_2 were found to be $(6.5 \pm 0.4) \times 10^{-15}$ and $(10.9 \pm 4.5) \times 10^{-15}$ cm^3, respectively. (auth)

28100 CESIUM RESONANT TOTAL CHARGE-TRANSFER CROSS SECTION AND OSCILLATORY STRUCTURE. Perel, Julius (Electro-Optical Systems, Pasadena, Calif.); Daley, Howard L.; Smith, Francis J. Phys. Rev., A; 1: 1626-31 (Jun 1970).

A more detailed measurement and calculation are reported for the $Cs^+ + Cs$ charge-transfer cross section, which contains continuous uniform oscillatory structure. Ten oscillation maxima are experimentally observed in the energy range from 0.6 to 21 keV. The oscillations are regular with inverse velocity and appear to show two superimposed oscillation frequencies. Calculations suggest that this may be due to the combined effect of a maximum in the interaction potential difference and of a large repulsive electron core, each generating a separate oscillation. It is shown that there is a very wide range of different potentials that could explain the oscillations. (auth)

28101 ION IMPACT SPECTROSCOPY: INELASTIC SCATTERING OF 150- TO 500-eV H^+ AND H_2^+ FROM N_2, CO, C_2H_2, AND

C_2H_4. Moore, John H, Jr.; Doering, John P. (Johns Hopkins Univ., Baltimore). J. Chem. Phys.; 52: 1692-9(15 Feb 1970).

A high-resolution ion-impact spectrometer was constructed to measure the energy lost by ions inelastically scattered from molecular targets. Inelastic collisions between 150- to 500-eV H^+ and H_2^+ and N_2, CO, C_2H_2, and C_2H_4 were observed in which the energy lost corresponded to electronic transitions in the target molecules. Most of the observed energy losses were assigned to known transitions in the targets. The cross sections for the observed electronic excitations are large. Ion-impact excitation in the cases studied appears to be a very specific process because only certain types of transitions are excited in molecules that have a large number of available electronic states. Proton impact was found to excite only singlet–singlet transitions while H_2^+ impact preferentially excited certain types of singlet–triplet transitions. The implications of the specific nature of the observed excitation as well as the general spectroscopic utility of the method are discussed. (auth)

28102 TRANSITION PROBABILITIES IN MOLECULAR COLLISIONS: COMPUTATIONAL STUDIES OF ROTATIONAL EXCITATION. Levine, R. D. (Hebrew Univ., Jerusalem); Shapiro, M.; Johnson, B. R. J. Chem. Phys.; 52: 1755-67(15 Feb 1970).

Exact numerical solutions are presented for the coupled-state formulation of a rigid-rotor–structureless-atom collision, and are compared with qualitative ideas and semiquantitative decoupling approximations for the system. The advantages of using an adiabatic basis for the internal states of the system are demonstrated, in distorted-wave-type computations and in accounting for the direct part and the resonance energies in slow inelastic collisions, in the absence of curve crossing. The diabatic regime is also considered, and a diabatic basis is used for a curve-crossing problem. For these slow, head-on collisions, the Franck–Condon factors are not exponentially small, and significant ($>10^{-4}$) transition probabilities are possible. (auth)

28103 THEORY OF INELASTIC COLLISIONS: THE WKB-TYPE GENERAL SOLUTIONS. Eu, Byung Chan (McGill Univ., Montreal). J. Chem. Phys.; 52: 1882-93(15 Feb 1970).

The WKB-type general solutions to a set of two and three coupled Schrödinger equations are obtained. A set of rules of obtaining the WKB general solutions for an arbitrary number of coupled Schrödinger equations is conjectured. These rules reduce the solution of the coupled equations to a problem of linear algebra The special cases of the solutions for the two and three coupled equations are considered. (auth)

28104 TEMPERATURE DEPENDENCES OF THE RATE COEFFICIENTS FOR THE REACTIONS OF Ar^+ WITH O_2, H_2, AND D_2. Adams, N. G.; Bohme, D. K.; Dunkin, D. B.; Fehsenfeld, F. C. (ESSA Research Labs., Boulder, Colo.). J. Chem. Phys.; 52: 1951-5(15 Feb 1970).

A series of measurements was made using the flowing afterglow technique to investigate the temperature dependence of the rate coefficients for the reactions of Ar^+ with O_2, H_2, and D_2 in the temperature range 80 to 560°K. The rate coefficient for the reaction of Ar^+ with O_2 was found to decrease with increasing temperature approximately as $T^{-0.5}$. In contrast, the rate coefficients for the reactions of Ar^+ with H_2 and D_2 increased with increasing temperature, and the rate coefficients for the reactions $ArH^+ + H_2$ and $ArD^+ + D_2$ were independent of temperature within experimental error. The rate coefficient for the reaction of Ar^+ with N_2 was measured at 280°K and found to be dependent on the Ar number density. (auth)

28105 THRESHOLD ELECTRON-IMPACT EXCITATION TO THE $\alpha^3\Pi$ STATE OF CARBON MONOXIDE. Brion, C. E.; Olsen, L. A. R. (Univ. of British Columbia, Vancouver). J. Chem. Phys.; 52: 2163-4(15 Feb 1970).

Results of an electron-scavenging study of threshold electron-impact excitation to the $\alpha^3\Pi$ state of carbon monoxide are presented briefly and are compared with results of studies by other techniques. It is concluded that there must be some basic difference between trapped-electron results and results obtained by other techniques. (A.G.W.)

28106 CURVE-CROSSING CALCULATIONS FOR ION-PAIR FORMATION BY OXYGEN INCIDENT ON ALKALIES. Van Den Bos, J. (Univ. of Nebraska, Lincoln). J. Chem. Phys.; 52: 3254-6(15 Mar 1970).

The Landau–Zener–Stueckelberg approximation was applied to the process of forming a singly negative oxygen ion and a positive alkali ion by oxygen incident on one of the alkalies Na, K, Rb, or Cs. A central-field potential model with an adjustable parameter was used to produce the wave functions with eigenenergy as close as possible to the experimental value. The impact parameter method was used to calculate cross sections for oxygen kinetic energies from 20 eV to 10 keV. (auth)

28107 RESULTS ON THE REACTION $D + H_2 \rightarrow HD + H$ USING MODULATED CROSSED BEAMS. Geddes, J.; Krause, H. F.; Fite, W. L. (Univ. of Pittsburgh). J. Chem. Phys.; 52: 3296-7 (15 Mar 1970).

The laboratory angular distribution and the mean velocities of HD molecules produced in the reaction $D + H_2 \rightarrow HD + H$ were measured in a modulated-crossed-beam experiment. The results strongly support a model of the reaction proceeding through the formation and rapid dissociation of a linear D–H–H complex. (A.G.W.)

28108 DIFFERENTIAL ELASTIC SCATTERING OF D_2 BY N_2 IN CROSSED MOLECULAR BEAMS. Winicur, Daniel H.; Moursund, A. L.; Deveraux, W. R.; Martin, L. R.; Kuppermann, Aron (California Inst. of Tech., Pasadena). J. Chem. Phys.; 52: 3299-3301(15 Mar 1970).

The differential elastic scattering cross sections for D_2 by N_2 were measured by a crossed-beam technique. Quantum mechanical rapid interference oscillations were observed from 2 to 20° cms. The experimental results were compared with reduced cross sections calculated by the quantum mechanical method of partial waves using JWKB and high-energy phases at low and high l, respectively. The spacing of the rapid oscillations was found to be very sensitive to the position of the potential zero and relatively insensitive to the potential-energy well depth and the potential shape. (A.G.W.)

28109 QUANTUM MECHANICAL ANALYSIS OF THE ELASTIC SCATTERING OF REACTIVE SYSTEMS. Eu, Byung Chan (McGill Univ., Montreal). J. Chem. Phys.; 52: 3021-37(15 Mar 1970).

A numerical method of calculating optical phase shifts for a spherically symmetric complex potential is described. Computations of optical phase shifts are carried out for the purposes of analyzing phenomenologically the elastic scatterings of chemically reactive systems and examining the behavior of the so-called opacity function. It is shown that the calculated phase shifts may be concisely represented in terms of a set of reduced variables. The existence of the reduced variables is very useful and conveniently exploited in the analysis of the elastic scattering of K + HBr system at E = 1.49 kcal/mole. The calculated phase shifts for various potential models are presented in tables and figures. (auth)

28110 IONIZATION OF ATOMS BY COLLISIONS WITH METASTABLE HELIUM ATOMS. Matsuzawa, Michio (Tokyo Univ.); Katsuura, Kanji. J. Chem. Phys.; 52: 3001-4(15 Mar 1970).

A theoretical calculation for the cross section $He(2^3S) + He(2^3S) \rightarrow He(1^1S) + He^+ + e$ is carried out using the impact parameter method, and with and without the approximation of straightline trajectory. It is shown that the accuracy of wave functions is not so important and the ionization cross section is determined mainly by the interatomic potential between the two colliding particles. The validity of the semiempirical treatment for the process $He(2^3S) + X \rightarrow He(1^1S) + X + e$ by Ferguson, by Bates et al., and by Jones et al. is discussed. (auth)

28111 RELATIVE ELECTRON IMPACT IONIZATION CROSS SECTIONS BY A DOUBLE CROSSED-BEAM TECHNIQUE. Rovner, L. H.; Norman, J. H. (Gulf General Atomic Inc., San Diego, Calif.). J. Chem. Phys.; 52: 2946-9(15 Mar 1970).

Accurate values of electron-impact ionization cross sections of high-temperature species are of importance in mass spectrometric investigations as well as a variety of other fields. However, the present experimental techniques are subject to many inherent difficulties or are limited in applicability and have yielded relatively few reliable values. Theoretical calculations are not sufficiently accurate. An experimental technique for accurate measurement of relative cross sections is described. The measurement depends only on one experimentally determined quantity, as well as the mass and temperature of the gaseous species, and is applicable to a wide variety of systems. The technique utilizes a mass spectrometer that is fitted with a Knudsen cell and employs electron impact ionization. A second, modulated electron beam intercepts the molecular beam, causing a slight modulation in the intensity of the molecular beam that is reflected in the output signal of the mass spectrometer. The relative attenuations of the various component species of the molecular beam are proportional to the relative total ionization probabilities of these species. The relative cross sections for Ca, Tl, Ag, and Pb have been measured and are compared with literature values obtained by other techniques. Preliminary application has also been made to the molecular species W_2O_6 and W_3O_9. (auth)

28112 ENERGY LOSS OF PROTONS IN GASES. Swint, J. B.; Prior, R. M.; Ramirez, J. J. (Univ. of Florida, Gainesville). Nucl. Instrum. Methods; 80: 134-40(1970).

Energy loss of protons in N_2, air, O_2, Ne, Ar, Kr, CH_4 and CO_2 has been measured as a function of incident energy from 0.4 to 3.4 MeV. The incident beam of protons from a Van de Graaff accelerator was scattered from a thin gold foil into an isolated gas cell. A surface barrier solid state detector and a 512-channel pulse height analyzer were used to measure the energy of the protons after they had traversed the gas cell. The experimental results obtained have a probable error of 2-5%. Comparison of these results has been made with available experimental results, Whaling's stopping power curves and the Lindhard-Scharff theory. (auth)

28113 ELECTRON-ATOM SCATTERING. Burke, P. G. (Queen's Univ., Belfast). pp 193-248 of Scattering Theory. /Barut, A. O. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

In this review of theory of electron-atom scattering, the interaction of two electrons in the field of a proton is considered first. The problems involved in defining boundary conditions and scattering amplitudes are introduced. The theory is then extended to elastic scattering of electrons by more complex atomic systems. The analytic properties of the scattering amplitude and resonance reactions, particularly when long-range atomic interactions are present, are discussed. (62 references) (A.G.W.)

28114 ATOM-ATOM SCATTERING. Smith, Kenneth (Univ. of Nebraska, Lincoln). pp 249-311 of Scattering Theory. /Barut, A. O. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The development of approximation schemes for interpretation and prediction of experimental data on atom-atom scattering processes is reviewed. The experimental data available on both symmetric and asymmetric collisions are surveyed in order to establish the features that are to be explained theoretically. Calculational methods currently being developed are then discussed with emphasis on the impact-parameter method and the full wave mechanical treatment. (86 references) (A.G.W.)

Atomic Theory

Refer also to abstract 27095.

28115 QUASIPARTICLE FORMALISM AND ATOMIC SHELL THEORY. Cunningham, M. J.; Wybourne, B. G. (Univ. of Canterbury, Christchurch, N. Z.). J. Math. Phys. (N. Y.); 10: 2149-55(Dec 1969).

The quasi-particle formalism developed by Armstrong and Judd for atomic shells is extended to expose the complete group structure of the quasi-particle eigenfunctions of the equivalent electron l-shell. A simple method for relating quasi-particle states to determinantal states and for calculating quasi-particle matrix elements is developed. The need for fractional parentage coefficients in calculating these matrix elements is entirely eliminated. (auth)

28116 SOME TYPES OF CLEBSCH-GORDAN COEFFICIENTS IN UNITARY SYMMETRY SCHEME CALCULATIONS. Kalinauskas, R.; Vanagas, V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos; 9: 685-93(1969). (In Russian).

Some types of Clebsch-Gordan coefficients of the SU_3-group in the case of special type reduction, connected with studying potential energy dependence on the total orbital momentum L, are given. The explicit expressions of Clebsch-Gordan coefficients for some types of $U_{3(n-1)}$-representations, occurring in the irreducible decomposition of the bilinear form, invariant with respect to the symmetric and three-dimensional rotational groups and constructed by infinitesimal operators of $U_{3(n-1)}$-group are obtained. (auth)

28117 MODIFIED WEIZSAECKER CORRECTIONS IN THOMAS-FERMI THEORIES. Goodisman, Jerry (Syracuse Univ., N. Y.). Phys. Rev., A; 1: 1574-6(Jun 1970).

Theories are considered in which a kinetic-energy correction $(\lambda\hbar^2/32\pi^2m)[(\nabla\rho)^2/\rho]$ (ρ = density) is added to the usual Thomas-Fermi term. A treatment based on the WKB method and expected to be valid for large r shows $\lambda = 1$ here, as found experimentally. For small r, $\lambda = 1$ is needed to give proper behavior of ρ, but other arguments suggest that the Thomas-Fermi term be dropped here. (auth)

28118 BOUND EIGENSTATES OF THE STATIC SCREENED COULOMB POTENTIAL. Rogers, F. J.; Graboske, H. C. Jr.; Harwood, D. J. (Univ. of California, Livermore). Phys. Rev., A; 1: 1577-86(Jun 1970).

Accurate numerical solutions were obtained for Schrödinger's equation for a two-particle system interacting through a static screened Coulomb potential (SSCP) $V(r) = -Ze^2e^{-r/D}/r$. The numerical integration of the wave equation uses a one-dimensional difference method, which is simple, accurate, and efficient. Solutions were computed for 45 eigenstates, 1s through n = 9, l = 8, yielding the eigenfunctions and energy eigenvalues for a wide range of D, the screening length that characterizes the range of the interaction. Under screening, all energy levels are shifted away from their unscreened values toward the continuum, the energy increasing as D decreases. For each n, l eigenstate, there is a finite value of the screening length $D_0(n,l)$, for which the energy becomes zero. The value of D_0 for the ground state of a two-particle bound system in a potential of this type, such as the Debye or Yukawa potential, is $0.83991\ a_0/Z$ in agreement with certain previous studies. The total number of different energy levels is finite for any finite D, and is approximately linearly dependent on D. The number of bound s states g^* is given by the relation $(g^*)^2 = 1.2677\ DZ/a_0$. For given n, the l degeneracy is destroyed, lowest l levels lying lowest in energy. At sufficiently high n, this behavior results in level crossing, high l levels of eigenstate n having higher energies than low l levels of eigenstate n + 1. This produces increasingly complex deviations of the level order from the unscreened order, commencing with the 5s-4f crossover. Because of the displacement of high n states into the continuum, the density of states in the SSCP for any finite D is lower than in the unscreened potential, especially near the continuum. (auth)

28119 STABILITY CONDITIONS FOR THE SOLUTIONS OF THE HARTREE-FOCK EQUATIONS FOR ATOMIC AND MOLECULAR SYSTEMS. II. SIMPLE OPEN-SHELL CASE. Paldus, J.; Cizek, J. (Univ. of Waterloo, Ont.). J. Chem. Phys.; 52: 2919-36(15 Mar 1970).

The stability conditions for the solutions of the Hartree-Fock equations for the simple open-shell case, i.e., closed shell with one extra electron, are derived. It is shown that only "doublet stability" is relevant in this simple open-shell case, the solutions being always "nondoublet unstable." The doublet stability conditions are then derived using the mathematical methods of quantum field theory, namely, occupation number representation, Wick's theorem, and Feynman-like diagrams. In order to familiarize the reader with the use of these concepts they are first used to rederive the singlet and nonsinglet stability conditions for the closed-shell case. A general method of finding new Hartree-Fock solutions, in the case that the symmetry-adapted Hartree-Fock solutions are unstable, is briefly discussed. The implications of the instability on the ground-state correlation energy calculations and on the excitation energy calculations using time-dependent Hartree-Fock theory are considered. (auth)

28120 GREEN'S FUNCTIONS IN ATOMIC AND MOLECULAR CALCULATIONS. Laurenzi, Bernard J. (Bryn Mawr Coll., Pa.). J. Chem. Phys.; 52: 3049-55(15 Mar 1970).

The use of Green's functions in calculations of second-order properties is presented. In the case of a second-order energy calculation for the helium atom it is found that the "discrete" part of the energy correction converges very rapidly. (auth)

Cosmic Radiation

Refer also to abstracts 27377, 27407, 28059, and 28522.

28121 (AECL-3561) COSMIC RAY NEUTRON AND MUON MONITOR DIURNAL VECTORS. II. From the Start of Solar Rotation No. 1813 to the End of Solar Rotation No. 1825, January 20, 1966-January 5, 1967, and Vector Diagrams by Solar Rotation. Steljes, John F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb 1970. 97p. Dep. CFSTI (U. S. Sales Only). AECL $2.00.

Daily diurnal and semidiurnal variation vectors for both the muon and the neutron monitors at 4 cosmic-ray stations in Canada which have equipment maintained by AECL are given in tabular form for the period from the start of solar rotation No. 1813 to the end of rotation No. 1825. The same vectors for the AECL neutron and muon monitors at Kula, Hawaii and for the Bolivian neutron monitor at Chacaltaya are also given. The vectors have been corrected for barometer and in the case of the muons, except at Kula, for the atmospheric temperature wave using hourly values of the temperature and barometric pressure measured near the ground. Graphs of the vectors at each station for successive solar rotations are also given. (auth)

28122 (AECL-3562) COSMIC RAY NM-64 NEUTRON MONITOR DATA FROM KULA, HAWAII, AND MONTHLY GRAPHS, JANUARY-DECEMBER 1969. Carmichael, H.; Steljes, J. F.; Kowalski, A. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb 1970. 46p. Dep. CFSTI (U. S. Sales Only). AECL $1.50.

Uncorrected and barometer-corrected hourly data from a 3-NM-64 mobile latitude survey neutron monitor stationed at Kula, Maui, Hawaii are given in tabular form for the period from January 1969 to December, 1969. Correction factors for the constant rate of drift of the barometer were determined. Graphs of the corrected data are given. (auth)

28123 COSMIC-RAY MUONS FROM LOW GALACTIC LATITUDE. Chu, William T. (Ohio State Univ., Columbus); Kim, Young S.; Reber, Grote. Publ. Astron. Soc. Pac.; 82: 339-44(Apr 1970).

A sample of 1855 cosmic-ray muons with energy greater than 10 GeV was studied in the pictures of the Michigan-Argonne 40-inch heavy-liquid bubble chamber. Above 100 GeV, an excess of muons arriving from low galactic latitude was found. (auth)

28124 ABSOLUTE VERTICAL MUON INTENSITY OF COSMIC RAYS AT 1 GeV/c AT SEA LEVEL. Allkofer, O. C.; Dau, W. D.; Jokisch, H. (Univ., Kiel). Phys. Lett.; 31B: 606-8(27 Apr 1970).

The cosmic-ray muon flux at sea level in the vertical direction was measured with a range spectrometer at momentum of 1 GeV/c. The differential intensity amounts to $N = 3.21 \times 10^{-4}$ cm^{-2}sr^{-1}s^{-1} (MeV/c)$^{-1}$ ±5% and is about 31% higher than the value generally used as the normalization point for muon spectra. (auth)

28125 COSMIC ELECTRONS AND RELATED ASTROPHYSICS. Daniel, R. R.; Stephens, S. A. (Tata Inst. of Fundamental Research, Bombay). Space Sci. Rev.; 10: 599-671(Apr 1970).

The vital contributions already made and those anticipated from a study of cosmic-ray electrons to cosmic-ray astrophysics are considered. Topics covered in this extensive review include experimental methods, cosmic electrons in the solar system, cosmic electrons in interstellar space, cosmic electrons and the galactic continuum radio emission, propagation and confinement of cosmic electrons, and electrons in the Metagalaxy. 209 references. (W.D.M.)

28126 COSMIC RAY NUCLEI OF CHARGE Z ≥ 3 DURING THE PERIOD OF LOW SOLAR ACTIVITY. Anand, K. C. (Tata Inst. of Fundamental Research, Bombay); Biswas, S.; Lavakare, P. J.; Ramadurai, S.; Sreenivasan, N.; Bhatia, V. S.; Chohan, V. S.; Pabbi, S. D. Proc. Indian Acad. Sci., Sect. A; 70: 201-20 (Nov 1969).

A detailed study of the composition and energy spectra of heavy nuclei of charge Z ≥ 3 in the primary cosmic rays was made during the period of low solar activity, using two stacks of nuclear emulsions exposed in balloon flights from Fort Churchill, Canada, in June 1963. Each of the stacks was composed of 120 nuclear emulsions of three different sensitivities and was exposed at about 3.5 g·cm^{-2} of residual atmosphere for about 11.1 hr. Reliable resolution of charges of nuclei from lithium to oxygen was obtained; for heavier nuclei, charge groups were determined. 793 tracks of nuclei with Z ≥ 3 were analyzed. (auth)

28127 CONVECTION, DIFFUSION, AND ADIABATIC DECELERATION OF COSMIC RAYS IN THE SOLAR WIND. Jokipii, J. R.; Parker, E. N. (Univ. of Chicago). Astrophys. J.; 160: 735-44(May 1970).

A generalization and clarification of work on the transport of cosmic rays in the solar system are presented. The general equations for the cosmic-ray density and flux, in the anisotropic-diffusion approximation, are derived in the frame of reference moving with the solar wind, and the transformation to the fixed frame is discussed. Only if the particle density varies smoothly with energy does one obtain a straightforward generalization of equations derived previously for isotropic diffusion. In this approximation is written down, for the first time, the correct differential equations for the particle density and flux for anisotropic diffusion. If the density varies sharply with energy, more complex integro-differential equations arise. It is concluded that existing alternative derivations, based on the Boltzmann equation, are in general not adequate for either anisotropic-diffusion or energy transformations. (auth)

28128 ON THE DIFFUSION-LOSS MODEL OF COSMIC-RAY ELECTRON PROPAGATION IN THE GALAXY. Webster, A. S. (Cavendish Lab., Cambridge, Eng.). Astrophys. Lett.; 5: 189-92(May 1970).

It is shown to be unlikely that the observed break in the cosmic-ray electron spectrum at about 3 GeV is caused by a diffusion-loss process. (auth)

28129 AN EFFECT ATTRIBUTED TO THE CHANGE IN THE PRIMARY CHEMICAL COMPOSITION OF COSMIC PARTICLES IN THE INTERVAL OF MAGNETIC RIGIDITY 10^{15} TO 10^{17} V. Catz, Philippe; Gawin, Jerzy; Maze, Roland; Wdowczyk, Jerzy; Zawadski, Alexandre (Laboratoire de Physique Cosmique, Essonne, France). Compt. Rend., Ser. B; 269: 1056-9(17 Nov 1969). (In French).

An analysis of measurements of the ratio N_μ/N_e for large showers received for different inclinations of their axes permits an abnormal variation of the exponent α in the relation $N_\mu \approx N_e^\alpha$ to be shown as a function of N_e. Such an abnormality is probably due to a change of the chemical composition of the primary cosmic radiation. (tr-auth)

28130 INTERSTELLAR COSMIC-RAY SPECTRA FROM THE NONTHERMAL RADIO BACKGROUND FROM 0.4 TO 400 MHz. Goldstein, M. L. (Univ. of Maryland, College Park); Ramaty, R.; Fisk, L. A. Phys. Rev. Lett.; 24: 1193-6(25 May 1970).

The interstellar electron spectrum is deduced from the nonthermal radio background. From 200 MeV to a few GeV the spectral index is 1.8 and there is evidence for residual solar modulation. Above a few GeV, the spectrum is steeper and the intensity is similar to that observed at Earth. A consistent modulation for electrons and protons of the same rigidity can be obtained by using the complete diffusion-convection energy-loss theory of solar modulation. (auth)

28131 EMISSION OF COSMIC RAYS BY A DIPOLE MAGNETOSPHERE. Pizzelle, G. (Univ. of Iowa, Iowa City). Nature (London); 226: 434-5(2 May 1970).

It is considered that studies of the Van Allen belt may throw light on some of the phenomena that occur in stars where plasma is trapped by strong magnetic fields. One problem is the origin of the high-energy trapped charged particles in the belt. Experimental evidence appears to indicate that the trapped protons of energy up to a few hundred MeV are due to the action of an unknown acceleration mechanism in the magnetosphere. Low-energy protons might emanate from the solar wind, or from the ionosphere, but they have to be accelerated to produce the observed high-intensity radiation which, for instance, at a geocentric distance of 1.4 R_E represents a flux at the equator of $\propto 10^4$ protons/cm^2/sec with energy >50 MeV. The question arises as to what is the ultimate fate of these particles when they have reached an energy so high that the Earth's magnetic field cannot contain them. It is shown that the energy spectrum of the particles that leave the magnetosphere is very similar to the observed energy spectrum of the primary cosmic radiation, suggesting that cosmic rays could be generated in Earth-like magnetospheres, for instance, in magnetospheres associated with neutron stars. It has already been proposed that neutron stars could supply the energy for the cosmic rays. Consideration is given to charged particles trapped in a dipole magnetic field and the mode of their untrapping. (UK)

28132 ELECTROMAGNETIC COMPONENT OF LARGE AIR SHOWERS. Kellermann, E. W.; Towers, L. (Univ. of Leeds, Eng.). J. Phys., A (London); 3: 284-95(May 1970).

Nine scintillators each of area 1.1 m^2 and 7.8 g cm^{-2} thickness were placed 500 m from the center of the Haverah Park array. Comparison of the signals from these detectors with the Haverah Park Čerenkov tanks near them, and analysis of the energy-loss spectra measured by the scintillators at larger distances from the cores of showers of nominal size 2×10^7 particles, yielded the lateral distributions of number and energy flux of the incident electromagnetic component from 200 to 1100 m. It was found that the energy flux of this component, mainly photons, varied over this distance from 1000 MeV m^{-2} to 1 MeV m^{-2} and the photon number from 1000 m^{-2} to 1 m^{-2}. Spectra of the photons incident at the larger core distances were obtained in fair approximation. (auth) (UK)

Direct Energy Conversion

Refer also to abstracts 27773 and 28307.

28133 (AD-699253) IONIZING FRONTS IN PLASMA PROPULSION AND POWER GENERATION SYSTEMS. Final Scientific Report, 1964-1969. Rosciszewski, Jan (Air Vehicle Corp., San Diego, Calif.). Jul 1969. Contracts AF49(638)-1357; F44620-68-C-0052. 191p. (AFOSR-69-2160-TR). CFSTI.

Analytical work associated with plasma propulsion and power generation systems is discussed. Some papers are relatively closely related to experimental work and are designed to describe analytically the physical phenomena in plasma propulsion and power generating systems. Other work represents feasibility studies of new concepts in these fields. Another group

of papers represents development of an analytical tool applicable to analysis of flow interacting with an electromagnetic field. (auth) (USGRDR)

28134 (AD-699661) PLASMA PHYSICS AND PROBLEMS OF MAGNETOHYDRODYNAMICS IN THE TRANSFORMATION OF ENERGY. Millionshchikov, M. D. Translated from pp 217-36 of Oktyabr i Nauchnyi Progress, Moscow, 1967. 27p. (FTD-MT-24-154-69). CFSTI.

Progress being made in creating magnetohydrodynamic generators in the Soviet Union is described. The article opens with a general discussion of the problems encountered in transforming the energy contained in chemical fuels into electrical energy. Efforts to overcome these problems have led to magnetohydromagnetic generators in which current is caused to flow in liquid, gas (plasma), or gas-liquid conductors moving through a magnetic field. Implementation of this principle has become possible in recent years due to development of good liquid and gas conductors, new heat-resistant materials, high temperature technology, the technology of superstrong magnetic fields, and large superconducting magnetic systems. (auth) (USGRDR)

28135 (AD-699944) PRACTICAL ASPECTS OF FUNDAMENTAL RESEARCH IN THERMIONIC CONVERSION. Final Technical Report, March 1-September 1, 1969. Rasor, Ned S. Dec 1969. Contract N00014-69-C-0279. 60p. (NSR-1-1). CFSTI.

Factors in basic thermionic converter research are summarized that are potentially important to the success of the engineering programs. An elementary phenomenology-based analytical description of cesium diode converter operation is formulated to serve as an intuitive bridge between the device engineering and physical electronic technologies. The theoretical description of the emission properties of surfaces immersed in cesium vapor is generalized and extended to explain effects of additives and impurities, which have been poorly understood. Thermionic emission of negative cesium ions from the collector is explored as a possible mechanism causing anomalous effects at the collector. A synopsis of the interrelation of basic converter physics and thermionic reactor design is developed, which indicates that substantial engineering advances are achievable primarily through reduction of electron energy losses in the converter. (auth) (USGRDR)

28136 (AD-700945) BASIC RESEARCH IN THERMIONIC ENERGY CONVERSION. Technical Summary Report, August 1, 1968-November 30, 1969. Warner, Charles; Hansen, Lorin K. (Atomics International, Canoga Park, Calif.). Dec 1969. 100p. (AI-69-112). CFSTI.

The program was directed toward an understanding of the fundamental processes occurring in thermionic energy converters and the effects of these processes on overall converter performance. A theoretical approach was studied for solving the equations that describe the wide-spaced diode. In the past these equations have not been solvable with available techniques. With some reservations the new computer results agree with available experimental data. Secondly, the trapping of ions in potential wells was studied and a new criterion has been developed which relates parameters associated with double-sheath emission barriers. This criterion will be useful in deciding the essential physics of converters operating below the knee of the I-V curve. (auth) (USGRDR)

28137 (AD-701446) LARGE SCALE POWER DEVELOPMENT. Dicks, John B. Jr. (Tennessee Univ., Tullahoma. Space Inst.). Jun 1969. Contract F44620-69-C-0031. 17p. (AFOSR-70-422-TR). CFSTI.

The engineering problems, economics, pollution aspects and feasibility of technically advanced large-scale central power plants are discussed. Particular emphasis is given to MHD topping of central power station steam plants, the most recent development in this field. (auth) (USGRDR)

28138 (N-70-16932) MHD BOUNDARY LAYERS WITH NON-EQUILIBRIUM IONIZATION AND FINITE RATES. Quarterly Report, June 1-September 1, 1969. Sherman, Arthur; Yeh, Hsuan; Reshotko, Eli (Computer and Applied Sciences, Inc., Philadelphia, Pa.). [1969]. Contract NASw-1866. 38p. (NASA-CR-107804). CFSTI.

The problem being considered is the boundary layer that will develop over the segmented-electrode wall in an MHD channel when a nonequilibrium plasma is flowing. A theoretical analysis for a nonequilibrium boundary layer was developed, explicitly taking into account the electron temperature differential equation and the plasma sheath. This analysis was developed using a finite-difference format so that finite electrodes along a wall could be treated in a nonsimilar manner. The present program seeks to extend this earlier study to include finite ionization and recombination rates in order to make the analysis apply in a more realistic way to physically important situations. (auth) (STAR)

28139 (N-70-20274) POWER CONDITIONING EQUIPMENT FOR A THERMOELECTRIC OUTER PLANET SPACECRAFT. Quarterly Technical Report. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 15 Dec 1969. Contracts NAS7-100; JPL-952536. 132p. (NASA-CR-108784). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Covered is the analysis of requirements and the detailed circuit design phase of the power-conditioning electronics for a nuclear-powered outer planet scientific spacecraft with a twelve-year life. A study was completed to identify an optimum frequency range for operation of electronic power processors, and a comparison was made of three candidate electrical power distribution configurations. The electrical design of a two-phase inverter, a quad-redundant shunt regulator, a dc to dc converter, and typical power switching circuit was advanced and detailed schematics are presented. Additionally, the electronic piece parts of the front end of a Jensen oscillator were packaged utilizing thick-film microcircuit techniques for improvement. The objective was a design to provide regulated power for engineering and science subsystems from a radioisotope thermoelectric generator, and to perform switching and control functions for the effective management and distribution of electrical power. The baseline electrical power subsystem established provides an optimized design to match the power source with the electrical loads and also provides Peltier cooling at all times to extend thermocouple life. (auth) (STAR)

28140 (N-70-20278) THERMIONIC SPACECRAFT DESIGN STUDY. Phase 1 Report, February 4, 1969-January 4, 1970. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 20 Jan 1970. Contracts NAS7-100; JPL-952381. 451p. (NASA-CR-108893; GESP-7031). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Work from the first phase of a design study of nuclear-electric propelled unmanned spacecraft is reported. The electric power source is incore thermionic reactors based on either the flashlight or externally fueled diode concept. The study guidelines and approach are defined, and the characteristics of the candidate launch vehicles, thruster subsystem, and the payload and communications subsystem are presented. These areas are common to all candidate thermionic reactors. Two spacecraft/power plant configurations that deliver 270-kWe power to the power conditioning units are presented. This definition, presented for both the flashlight and externally fueled reactors, includes the key items of spacecraft arrangement and a detailed weight breakdown. Power conditioning, heat rejection subsystem, shielding and spacecraft structure are detailed. The results show about a 20 lb/kWe weight advantage for the spacecraft based on the externally fueled reactor. The computer code employed in the spacecraft weight optimization is discussed, and some preliminary discussion of key mission operations is presented. (auth) (STAR)

28141 (N-70-20418) PERFORMANCE OF CHEMICALLY VAPOR-DEPOSITED TUNGSTEN EMITTERS IN THERMIONIC CONVERTERS. Wang, C. C.; Rufeh, F.; Lieb, D. P. (Thermo Electron Corp., Waltham, Mass.). Nov 1969. Contract NAS3-9424. 67p. (NASA-CR-72623; TE-4068-182-68). CFSTI.

The performance of tungsten, deposited from its halides by hydrogen reduction of hexafluoride (fluoride tungsten) and hexachloride (chloride tungsten), as emitters of thermionic converters was studied in six planar geometry converters with niobium collectors and an interelectrode spacing of 8 ± 0.5 mils. The data are presented in the form of variable cesium temperature families and cover the emitter temperature range of 1600 to 2000°K. The results show that the maximum power achieved at a given emitter temperature with chloride tungsten emitters is higher than that achieved with fluoride tungsten emitters throughout the temperature range. For example, at an emitter temperature of 2000°K, the maximum power for chloride tungsten emitters is about twice that for fluoride tungsten emitters. It was also found that chemical etching of fluoride tungsten makes a considerable improvement in its performance. (auth) (STAR)

28142 EFFECT OF THE INBLOWING OF PROTECTIVE GASES INTO THE LAYER IN FRONT OF THE ELECTRODES ON THE DISCHARGE MODE OF POROUS ELECTRODES IN A MAGNETOHYDRODYNAMIC DEVICE. German, V. O.; Kukota, Yu. P.; Lyubimov, G. A. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 135-7 (Jan-Feb 1970). (In Russian).

Blowing in protective gases into the area near the electrodes was used as a protective measure against erosive and corrosive

attack by oxygen-containing plasma currents on the electrodes of magnetohydrodynamic devices. The tested cermet-type electrodes included refractory carbides and borides (TiC, ZrB_2, NbC + Co, ZrB_2 + LaB_6) with porosites ranging from 30 to 42%. The air stream containing 1.2% of K was flowing at a velocity of 350 m/sec at a temperature of 2600°K. Introduction of Ar and especially of N affected strongly the transition to arc discharge. Under certain conditions, the wear was reduced to zero for periods up to 10 minutes. No hysteresis was noted but the transition toward arc discharge became more marked and instabilities arose during the burning of the arc. Under otherwise identical conditions, the use of a neutral gas ensured a uniform discharge at higher voltages between the electrodes or allowed higher current densities to be used without initiating an arc discharge, thus helping to reduce the erosion of the electrodes. (TTT)

28143 MICRO-ARC TYPE OPERATION OF THE ELECTRODES OF A MAGNETOHYDRODYNAMIC GENERATOR. Zalkind, V. I.; Kirillov, V. V.; Larionov, Yu. A.; Semenov, N. S. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 130-4(Jan-Feb 1970). (In Russian).

The operation of the electrodes of a magnetohydrodynamic generator was investigated at relatively high current densities, using metallic and silicon carbide electrodes. It was found that, in case of operation at high current densities, micro-arcs are formed at the electrode surface. The boundary between the electrode and the insulator, where potassium compounds are deposited on the electrode surface, was found to exert a strong influence on the behavior of the arcs, which are considered as being responsible for the electro-erosion of the electrode. Such micro-arcs appeared on metallic cathodes at currents of 5 to 6 A with an electrode surface of 11 cm^2 under conditions close to short circuit. The damaging burning of arcs between the electrode and insulator may be prevented by improved design. (TTT)

28144 DIFFUSION OF A SLIP MAGNETIC FIELD IN A LINEAR GENERATOR HAVING SEVERAL ZONES OF DIFFERENT CHARACTERISTICS. Kant, Michel; Bonnefille, Robert (Paris Univ., Fontenay-aux-Roses, France). Compt. Rend., Ser. B; 270: 592-5(2 Mar 1970). (In French).

The equations of diffusion of a magnetic field in a linear generator where there are several zones of different resistivity and permeability are established. A few conclusions about the optimization of the linear induction converters are drawn from the general solutions of these equations. (France)

28145 SEEDED CESIUM PLASMA DIODES AND THE PENNING EFFECT. Kaufman, A. J.; Schrenk, G. L. (Univ. of Pennsylvania, Philadelphia). Energy Convers.; 9: 145-7(Dec 1969).

A proposal for improving the performance of cesium plasma diodes by increasing the ionization rate by seeding with Hg or Cd is discussed. Such an enhancement is believed due to the Penning effect. A theoretical investigation was made of the effects of such seeding, and a model was developed for both a pure Cs and a Cs-seeded diode, including the Penning effect. Results from this model compared favorably with available experimental data. It was found that the electron temperature for a pure Cs diode operating in the ignited mode lies in the range 2,300 to 2800°K. The model covers both the ignited and unignited modes, and clearly shows where significant enhancements due to seeding can be expected; unfortunately, the region where significant enhancements are obtainable is near the maximum power point. (UK)

28146 TESTS OF A NUCLEAR-TYPE CONVERTER WITH AN ADSORPTION CESIUM RESERVOIR. Defranould, P. (Compagnie Francaise Thomson Houston Hotchkiss Brandt, Bagneux, France). Energy Convers.; 9: 149-53(Dec 1969).

A cylindrical converter with porous metal (W or Mo) as adsorbate material in its envelope was built, and with a liquid Cs tank communicating with the converter through a metallic gate valve for use at high temperatures when the converter is working. Tests were made with and without liquid Cs. The first runs, of a few hundred hours duration, indicated good operation during the first 10 hours with only Cs vapor and no liquid Cs, after which the output power fell. Attempts are made to explain this fall. (UK)

28147 DEVELOPMENT IN THE DESIGN OF MHD POWER-GENERATING FACILITIES. Heat Transfer - Sov. Res.; 2: 128-37(Mar 1970).

The following subjects are discussed: stationary MHD power-generating facilities, studies pertaining to the design of liquid-metal MHD facilities, studies pertaining to the design of pulsed MHD generators, studies pertaining to development of superconducting magnet systems for MHD generators, and studies of fuel recovery from power-plant combustion products. (M.H.R.)

28148 THE CONTRIBUTION OF SPACE CHARGE IN SLENDER-CHANNEL ELECTROGASDYNAMICS. France, D. M.; Trezek, G. J. (Univ. of California, Berkeley). Energy Convers.; 9: 135-40(Dec 1969).

A general expression is given for the axially induced space charge electric field in an electrogasdynamic energy converter for an axially varying charge distribution, and by introducing an effective value of the space charge electric field an analytic solution is obtained for the load current in a manner similar to a theory proposed by Gourdine which did not take care of space charge effects. A comparison is made between computed values of the load current, voltage, and power output and experimental data for air over a range of load resistance from 10^7 to 10^{11} ohms. The space charge electric field computed for the case of constant axial charge distribution is also considered. (UK)

28149 POWER WITHOUT POLLUTION. Musgrove, Peter J.; Wilson, Alan D. (Reading Univ., Eng.). New Sci.; 45: 457-9 (5 Mar 1970).

Heat energy can be converted directly into electricity with high efficiency by sweeping charged particles through an electric field in a stream of gas. The size of this electrogasdynamic generator does not affect its efficiency and the potential is for a silent, low-pollution power supply. (auth) (UK)

28150 STUDY ON THE DUCT OF A MHD ACCELERATOR. Coghe, A.; Ghezzi, U. (Instituto di Macchine, Milan). Termotecnica (Milan); 23: 501-10(Oct 1969). (In Italian).

A type of MHD accelerator with radial geometry is studied and it is shown how it is possible to attain considerable specific impulses. It is emphasized that the increase of the magnetic field necessary to increase the specific impulse can lead to an intolerable temperature increase. From the necessity of optimizing the problem, solutions are derived that simultaneously allow the increase of the specific impulse with permissible temperature values. (tr-auth)

28151 ELECTROMAGNETIC ACCUMULATOR DEVICE. Sole, Jean (to Commissariat a l'Energie Atomique). British Patent 1,187,149. 8 Apr 1970. Priority date 20 Jul 1966, France.

An electromagnetic accumulator for storing electrical energy is designed that uses a superconducting circuit without the need of direct connection with the external supply circuit. The superconducting circuit comprises at least one superconducting sheet of closed-loop configuration and means for producing a moving magnetic field to induce moving localized zones of normal conductivity in the superconductive sheet, thereby building up the field and current within the closed loop. Several embodiments of the design are described. (D.L.C.)

28152 SHORT-CIRCUIT CURRENTS AND EMF IN SILICON AND SELENIUM PHOTOCELLS WITH A ^{235}U LAYER ON NEUTRON IRRADIATION. Lebedev, S. Ya.; Taurbaev, T. I. (Physico-Energetic Inst., Obninsk, USSR). Fiz. Tekh. Poluprov.; 4: 584-7(Mar 1970). (In Russian).

The direct conversion of the energy of fission fragments into electricity by semiconductor photocells coated with a layer of fissionable ^{235}U was studied, using silicon cells tested successfully as solar energy converters, and neutron-resistant selenium cells. The efficiency for a 4×10^{10} n/cm^2 sec radiation was found to be an order of magnitude higher than observed in the authors' earlier study. The CdSe–Se cells on an iron support had a ^{235}U layer of 0.45 mg/cm^2; the short-circuit currents were measured with and without the U layer. At a flux of 1.3×10^{12} n/cm^2 sec, the current in the specimens with U layer decreased because the fission fragments damaged the p–n transition. At a thermal neutron flux of 0.65×10^{14} n/cm^2 sec, the experiments could be carried on for only 1.5 minutes because the specimens became too hot. At that flux, the short-circuit currents were strongly affected by the time of exposure in both coated and U-free specimens. Without U, the current decreased as a result of the radiation-induced defects and the high temperature; the coated specimens exhibited a tendency toward saturation. This is probably due to the radiation annealing of defects in the region of the thermopeak caused by the fission fragments. (TTT)

28153 IMPROVEMENT IN OR RELATING TO THE GENERATION OF ELECTRICITY. Macbeth, Robert Victor (to United Kingdom Atomic Energy Authority). British Patent 1,190,009. 29 Apr 1970. Filed 27 Sep 1966.

Reference is made to electrodynamic systems for the generation of electricity. In the system described, the vapour employed as working fluid is expanded through a nozzle to subatmospheric pressure and high velocity and enters a low pressure ionisation zone, the kinetic energy of the ionised vapour conveying it along

a flowpath leading to an electrode, at which point the flowpath is bounded by a wall which is shaped so that the resultant envelope of ionized particles nowhere intercepts the wall, loss of charge to the wall thus being prevented. The ionisation may be effected by spraying electrons into the low pressure zone from an electrode at which a corona discharge is stimulated. Other means of ionisation may comprise the use of an rf field or a hot electrode emitter. Water vapour particles are particularly suitable for ionisation by electron attachment at the pressure obtaining. (UK)

28154 RUSSIANS PUSH MAGNETOHYDRODYNAMIC POWER TOWARD REALITY. Brogan, Thomas R. Power; 114: No. 5, 70-1(May 1970).

The various MHD development programs underway in the USSR are mentioned briefly. The specifications and expectations for the U-25 prototype natural-gas-fired central station are summarized. The U-25, which has the world's largest MHD generator, may produce 75 MW for Moscow this year. Only 25 MW will be produced by the MHD generator, however, remainder is generated by a bottoming steam plant. (M.H.R.)

28155 OUTLOOK FOR BINARY POWER PLANTS USING LIQUID-METAL MHD. Prem, L. L.; Parkins, W. E. (Atomics International, Canoga Park, Calif.). IEEE (Inst. Elec. Electron. Eng.), Spectrum; 7: No. 5, 35-44(May 1970).

Preliminary testing and extrapolations thereof indicate that liquid-metal MHD can be used as a topping cycle to increase the efficiency of large central-station power plants. Because maximum temperatures as low as 870°C are effective, such binary plants are possible with existing material technology. The best present choices appear to be a potassium working fluid and either a (helium- or sodium-cooled) nuclear reactor or a fossil-fueled furnace. Cost estimates for a possible plant with 1-GW output—based on the use of a coal-fired furnace operating at 870°C with a condensing type of MHD cycle—suggest that, for a capital-cost outlay approximately equal to that for a conventional coal-fired plant, 13 percent more efficiency is achieved by the plant with the topping cycle. (auth)

Fluid Physics

28156 (AD-693330) HEAT TRANSFER TO AN MHD FLUID, Final Technical Report, October 1, 1967–April 1969. Fan, L. T.; Hwang, C. L. (Kansas State Univ., Manhattan. Dept. of Chemical Engineering). Jun 1969. 10p. (AFOSR-69-2175-TR). CFSTI.

For the design of MHD devices—accelerators and generators—the calculation of the various losses is important. Among others, of great importance is the heat transfer to the walls of the channel and the electrodes. A study was made to investigate theoretically and numerically the magnetohydrodynamic channel-flow with the forced-convection heat transfer and the optimal design of MHD devices. (auth) (USGRDR)

28157 (N-70-16730) MHD BOUNDARY LAYERS WITH NONEQUILIBRIUM IONIZATION AND FINITE RATES. Quarterly Report, March 1–June 1, 1969. Sherman, Arthur; Yeh, Hsuan; Reshotko, Eli (Computer and Applied Sciences, Inc., Philadelphia, Pa.). 1 Jun 1969. Contract NASw-1866). 14p. (NASA-CR-107671). CFSTI.

The problem being considered is the boundary layer that will develop over the segmented electrode wall in an MHD channel when a nonequilibrium plasma is flowing. A theoretical analysis for a nonequilibrium boundary layer explicitly takes into account the electron temperature differential equation and the plasma sheath. This analysis was developed using a finite difference format so that finite electrodes along a wall could be geared in a nonsimilar manner. Finite ionization and recombination rates are included in order to make the analysis apply in a more realistic way to physically important situations. (auth) (STAR)

28158 TWO-DIMENSIONAL NON-STATIONARY FLOW OF LOW CONDUCTIVE FLUID IN MAGNETIC FIELD. Sharikadze, D. V. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR; 57: 29-32(Jan 1970). (In Russian).

The equations of two-dimensional nonstationary flow of a low-conductivity fluid in a transverse magnetic field are obtained. The uniqueness of the linear boundary-value problem is proved, and the representability of such a current-flow function by the Green function is given. The nonregular part of the Green function is written explicitly. (auth)

28159 INTRINSIC EQUATIONS OF STEADY GAS FLOWS. Purushotham, G.; Rao, Gopal Krishna (Nagarjuna Engineering Coll., Hyderabad, India. Osmania Univ., Hyderabad, India). Tensor; 21: 238-42(May 1970).

An attempt is made to study the various kinematic and kinetic properties of inviscid steady gas flows, considering the geometric properties of a vortex line. Considerations of the vortex line geometry and the basic necessary conditions to be satisfied by flow parameters are investigated. An analytic expression for vorticity is obtained in terms of the components of the velocity. Decomposing the basic equations governing the flow in intrinsic form it is observed that the Bernoulli surfaces contain vortex lines, if the specific entropy of a gas remains uniform along a vortex line. The variations of the specific entropy and the temperature along a vortex line and its principal normal and binormal are studied. The basic compatibility conditions governing a gas flow obtained by Berker are obtained in intrinsic form. Finally, an attempt is made to study the complex lamellar flow in geometric parameters of a vortex line. (M.H.R.)

28160 ON FLOW BEHIND MAGNETOGASDYNAMIC SHOCK IN THERMALLY CONDUCTING FLUID. Upadhyaya, U. S.; Upadhyaya, K. S. (Univ. of Allahabad, India). Tensor; 21: 224-8 (May 1970).

The velocity of propagation of magnetohydrodynamic shock in thermally conducting fluid and its differential effects on the flow are determined. (M.H.R.)

28161 HYDROMAGNETIC FLOW OF VISCOUS CONDUCTING FLUID BETWEEN TWO POROUS COAXIAL CYLINDERS IN THE PRESENCE OF A RADIAL MAGNETIC FIELD. Baral, M. C. J. Sci. Eng. Res., Indian Inst. Technol., Kharagpur; 12: 305-16 (Jul 1968).

Flow is analyzed for the case of incompressible fluid and infinitely long cylinders where the inner cylinder is driven by a series of longitudinal impulses that produce a time-varying pressure gradient in the fluid. With the Laplace transform, an exact solution in the complex domain is obtained for the very special case where the Reynolds number for the axial flow equals the magnetic Reynolds number. The inverse transformation to the real domain is then effected only under the further restriction that the Reynolds number for the cross flow (radial flow) is equal to zero. This restriction reduces the validity of the solution to either the case of a nonporous outer cylinder or to the trivial case of an outer cylinder of zero radius. It is contended that the solution for the velocity and field reduces to the purely hydrodynamic solution when the applied magnetic field, the fluid conductivity, and the longitudinal driving function are all zero. (App. Mech. Rev.)

28162 INITIAL-VALUE METHOD FOR THE SOLUTION OF MHD BOUNDARY-LAYER EQUATIONS. Na, T. Y. (Univ. of Michigan, Dearborn). Aeronaut. Quart.; 21: 91-9(Feb 1970).

An initial-value method is introduced for the solution of the two-point nonlinear ordinary differential equations resulting from an analysis of the MHD boundary-layer flow originally treated by Greenspan and Carrier. By using this method, the iteration process is eliminated. The method is seen to be applicable to the solution of similar two-point boundary value problems where certain physical parameters appear either in the differential equation or in the boundary conditions and solutions for a range of the parameters are sought. (auth)

28163 ELECTROHYDRODYNAMIC STABILITY OF A LIQUID JET. Mohamed, Abou El Magd A.; Nayyar, N. K. (Univ. of Delhi). J. Phys., A (London); 3: 296-303(May 1970).

The stability of a liquid jet under a time-dependent electric field was investigated. It was found that, for perturbations having large wavelengths, the electric field has a stabilizing effect. For perturbations having small wavelengths, there are resonance modes causing excitation of the perturbed surface of the jet. (auth) (UK)

Geophysics (Upper Atmosphere)

Refer also to abstract 28131.

28164 COSMIC LAYER IN THE LOW IONOSPHERE IS A REALITY. Nestorov, G. Compt. Rend. Acad. Bulg. Sci.; 23: 57-9(1970).

Cosmic-ray interactions in the atmosphere create an ionospheric layer of increased electron density that has an effect on the long- and very-long-wavelength radio waves. Results are reported on an 11-year observation of the absorption of the 164-kHz waves at night at Sofia. (W.D.M.)

28165 A GENERALIZATION OF THE SOLUTIONS FOR THE IONIZATION OF HIGH ATMOSPHERE FROM SOLAR COSMIC RAYS. Velinov, P.; Georgieva, G. Compt. Rend. Acad. Bulg. Sci.; 23: 61-4(1970).

Formulae for the electron production rate at height h in the lower ionosphere as a result of the penetration of solar particles

have been deduced previously. These formulae are discussed, and tables are given for b = 0.7, 0.8, and 1. (W.D.M.)

28166 ULTRA-LOW-FREQUENCY WAVES IN THE MAGNETOSPHERE. Dungey, J. W.; Southwood, D. J. (Imperial Coll. of Science and Tech., London). Space Sci. Rev.; 10: 672-88(Apr 1970).

Many of the more important properties of pulsations observed on the ground have been known for some time and two good reviews have been published recently (Troitskaya, 1967; Campbell, 1968). Consequently only a brief summary of these properties is given here and the remainder of the paper is devoted to observations from satellites and recent developments in the theory, which have shown considerable points of agreement with satellite observations. (W.D.M.)

28167 SOLAR AND LUNAR DAILY GEOMAGNETIC VARIATIONS AT SAN FERNANDO AND GREENWICH IN RELATION TO THE ASSOCIATED ELECTRIC CURRENT SYSTEMS. Chapman, Sydney; Fogle, Benson. Abh. Akad. Wiss. Goettingen, Math.-Physik. Kl.; No. 6, 67p(1968).

Seasonal and sunspot-cycle changes in the solar (S) and lunar (L) daily geomagnetic variations of horizontal force (H) and declination (d°) are compared at San Fernando and Greenwich stations. The former is near the path of FS while Greenwich is well north of FS. At both stations the seasonal variation is greater and the sunspot-cycle variation is less for L than for Sq. The Sq current system undergoes day-to-day changes, affecting the latitude of FS. For San Fernando, Sq(H) and L(H) were determined for two groups of days on which FS is in latitudes to north or south of its mean value. Results are examined in relation to possible associated average change of the latitude of focus FL of the L current system; little change, if any, is found in average L(H). The preferred interpretation is that San Fernando is near the latitude at which L(H) is maximum, where L(H) is likely to be least affected by changes of the L focal latitude. Additional solar daily variation SD associated with magnetic disturbance is also examined. (Geophys. Abstr.)

28168 YEAR-TO-YEAR CHANGE OF GEOMAGNETIC DAILY VARIATION FIELD. Yasuhara, Michihiro. Spec. Contrib. Geophys. Inst., Kyoto Univ.; No. 8, 1-8(1968).

The year-to-year change of the geomagnetic daily variation field during the period of 1958–1964, when there was a maximum-to-minimum stage of sunspot activity, is investigated using the method of spherical harmonic analysis. Coefficients of the cosine-term (the Sq part of the variation field) are shown to have good correlation with the relative sunspot numbers for both diurnal and semidiurnal terms, while those of sine-term do not. During this descending stage of sunspot activity, diurnal and semidiurnal amplitudes decreased to 1/2.2 and 1/1.9, respectively. (Geophys. Abstr.)

28169 SEASONAL VARIATION IN THE D-COMPONENT OF Sq NEAR THE DIP-EQUATOR. Murata, Hiroo. Spec. Contrib. Geophys. Inst., Kyoto Univ.; No. 8, 9-14(1968).

The seasonal variation of the geomagnetic D component of Sq is analyzed, using data of magnetically quiet days during the IGY at five selected magnetic observatories near the dip equator. Results show that the D component of Sq on the dip-equatorial zone has a seasonal as well as daily variation in equinox. The daily variation is due to the effect of disagreement of geographic and geomagnetic axes. The seasonal variation tends to be anti-symmetric with respect to the equator in summer and winter. The maximum value of its variation is reached at about 07, 12, and 18 LT, with values of about 15γ for the first two and 5γ for the latter. This variation of the D component in solstice seems to be caused by ionospheric currents flowing in the northern and southern hemispheres independently without crossing the dip equator; the magnetospheric current (several gammas at most) has a smaller effect on Sq at the Earth's surface than does the ionospheric current. (Geophys. Abstr.)

28170 THEORY OF AURORA BAND. Hasegawa, A. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 24: 1162-5(25 May 1970).

The predicted sheet current which connects the partial ring current and the auroral electrojet in auroral substorms is shown to be unstable against a shear perturbation (kink instability). A consequence of the instability is the deformation of the sheet current into a curtain shape as is visibly observed in auroras. (auth)

28171 A CYCLE OF THE INDICES Φ AND Φ_{F2}. Joachim, Miroslav; Vladimirov, Valdimir; Guillot, Pierre. (Union Internationale des Telecommunications, Suisse, France). Compt. Rend., Ser. B, 269: 1060-2(17 Nov 1969). (In French).

When the observation period of the index Φ reached two solar cycles it was possible to prepare calculations allowing the establishment of a polynomial representing a mean cycle of the values of Φ and Φ_{F2} according to a previous analogous method. The coefficients of the polynomials represent a mean cycle and are shown in a table. Curves are also shown giving the form of these two types of mean cycle. (J.F.P.)

Low-Temperature Physics

Refer also to abstracts 27294, 28151, 28449, 28460, 28461, and 29058.

28172 (CONF-680322-6) THERMAL CONDUCTIVITY, NUCLEAR SPIN RELAXATION RATE AND ULTRASONIC ATTENUATION OF HIGH FIELD SUPERCONDUCTORS. Engler, Hans (Frankfurt Univ. (West Germany). Institut fuer Theoretische Physik). [1967]. 38p. Dep. CFSTI (U. S. Sales Only).

From Conference on the Physics of Metals, Berlin, Germany.

The influence of the Pauli term on transport properties of high-field superconductors is investigated for arbitrary spin-flip times. In the calculations a distinction is made between thin films in a parallel field and superconductors in the mixed state. It is found that the Pauli term modifies the transport properties at sufficiently long spin-flip times, in contrast to the BCS theory. (auth)

28173 (N-69-25304) STUDY OF TRANSITION TEMPERATURES IN SUPERCONDUCTORS. Quarterly Progress Report, June 11-September 10, 1968. Vieland, L. J.; Cohen, R. W.; Hanak, J. J.; McEvoy, J. P. (Radio Corp. of America, Princeton, N. J. RCA Labs.). Contract NAS8-21384. 17p. (NASA-CR-98408). CFSTI.

Research falls into three main areas: extension of the band model to additional behavior (theoretical and experimental work on the transport properties of Nb_3Sn); probing the extent of the validity of the model by both physical (stress dependence of T_c) and chemical (doping) experiments; and searching for possible interactions needed to remedy certain deficiencies in the theory (neutrons diffraction, magnetic field dependence of the elastic constants). In addition, work continues on the attempted growth of large single crystals of Nb_3Sn. (auth) (STAR)

28174 (ORNL-TM-2980) MAGNETIC FLUX FLOW AND SUPERCONDUCTOR STABILIZATION. Final Report, October 1, 1969-December 31, 1969. Gauster, W. F.; Ihara, S.; Lubell, M. S. (Oak Ridge National Lab., Tenn.). May 1970. 58p. Dep. CFSTI.

A new graphical method for determining the current-voltage characteristics of superconducting wires in the flux flow state is presented. It can be applied to bare and stabilized wires. The cases of "thin" and "thick" filaments are considered. It is shown that realistic cryostatic stability criteria can be obtained only from the shape of the complete current-voltage characteristic and not simply from the slope of the tangent at the starting point of the flux flow characteristic. Furthermore, paradoxical results can be avoided if the dependence of the superconducting current on the electric field strength is taken into account. A review of the entire work performed from April 1, 1967 to December 31, 1969 is presented with detailed references to the various individual progress reports. An Appendix deals with recent research activities with Nb-Ti compound conductors with twisted filaments. (auth)

28175 (UCRL-19096) INTERACTION OF HIGH FREQUENCY ELECTROMAGNETIC RADIATION OF SUPERCONDUCTING POINT CONTACT JUNCTIONS. Sterling, Stewart Allen (California Univ., Berkeley. Lawrence Radiation Lab.). Dec 1969. Contract W-7405-eng-48. 99p. Dep. CFSTI.

Thesis.

Experimental evidence is presented on the interaction of millimeter and submillimeter electromagnetic radiation with point contact Josephson junctions. Changes in the dc current-voltage characteristic are used to measure changes in ac Josephson currents coupled to radiation fields, and the detection properties of such junctions are discussed in detail. Evidence is presented for feedback-narrowed response when the ac Josephson currents are strongly coupled to a resonant cavity. The observed response shows high sensitivity (NEP $\lesssim 5 \times 10^{-15}$ W/$\sqrt{\text{Hz}}$) and frequency selectivity ($Q_{eff} \gtrsim 10^3$). The Werthamer-Shapiro theory was extended to include the effects of applied radiation at the resonance frequency and is shown to account for the feedback narrowing. In addition, evidence for the frequency dependence for the ac currents is presented. (auth)

28176 (UCRL-19163) LOW-TEMPERATURE HEAT CAPACITIES OF SUPERCONDUCTING DEGENERATE SEMICONDUCTORS. Phillips, N. E.; Triplett, B. B.; Clear, R. D.; Simon,

H. E.; Hulm, J. K.; Jones, C. K.; Mazelsky, R. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec 1969. Contract W-7405-eng-48. 12p. (CONF-690831-1). Dep. CFSTI.

From Conference on Science of Superconductivity, Stanford, Calif.

Low-temperature heat capacities of a number of samples of SnTe and $SrTiO_3$ with varying carrier densities n_c were measured. For SnTe, the Debye temperature θ_D is practically independent of n_c. The coefficient of the electronic heat capacity γ varies regularly with n_c but in a more complicated way than expected for a simple band. The $SrTiO_3$ samples all show appreciable deviation from the temperature dependence expected for the sum of lattice and electronic contributions and, consequently, the values of γ and θ_D are uncertain. For a Nb-doped $SrTiO_3$ sample, the increase in heat capacity with applied magnetic field is very much smaller than for a reduced sample with similar n_c. This provides further support for the author's earlier suggestion that the difference in T_c between Nb-doped and reduced samples, and possibly the maximum in T_c for reduced samples, is related to the presence of paramagnetic ions. (auth)

28177 THEORY OF ULTRASONIC ABSORPTION IN A SUPERCONDUCTOR. Forgan, E. M.; Vinen, W. F. (Univ. of Birmingham, Eng.). J. Phys., C (London); 3: 222-34(Jan 1970).

The theory of ultrasonic absorption in a superconductor is treated by a method that is similar to that commonly used for analogous problems in superfluid helium, namely in terms of a pair of coupled equations, one of which is the superfluid equation of motion and the other is a Boltzmann equation describing the behavior of the excitations. The particular equations used are straightforward generalizations to a charged Fermi superfluid system of those used by Khalatnikov (1965) for superfluid helium. The results obtained for the attenuation of both longitudinal and transverse waves (for all values of ql) are in accord with accepted theory. The present treatment gives a rather detailed picture of the processes occurring in a sound wave in a superconductor, and it serves to emphasize the close similarity that exists in simple cases between a superconductor and superfluid helium. (auth) (UK)

28178 POSSIBLE COEXISTENCE OF SUPERCONDUCTIVITY AND FERROMAGNETISM IN MIXED CRYSTALS OF THE TYPE $Ce_{1-x}Tb_xRu_2$. Hellenbrand, B.; Wilhelm, M. (Siemens AG, Erlangen, Ger.). Phys. Lett.; 31A: 448-9(20 Apr 1970).

The superconducting transition temperature T_c, the Curie temperature Θ_c, and the susceptibility at Θ_c, are plotted against the Tb concentration in mixed crystals of the composition $Ce_{(1-x)}Tb_xRu_2$. The width of the superconducting transition step defines T_c, and is indicated by the inductance change of a coil surrounding the sample; Θ_c is indicated by the maximum of the susceptibility as a function of temperature. The measurements were made with powdered samples of about 0.6 g at a frequency of 865 Hz. (M.H.R.)

28179 ENERGY GAP AND THE STABILITY OF THE SOLUTION DESCRIBING THE SUPERCONDUCTING STATE. Galasiewicz, Z. (Wroclaw Univ. Inst. of Low Temperatures and Structural Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys.; 17: 769-73(1969).

The most important result of the generalized Hartree–Fock variational principle is the possibility of finding the solution describing the superconducting state and proving that the Hartree–Fock solution corresponds to the normal state. Here the problem of stability, i.e., the problem of the sign of the second variation for the "superconducting" solution, is considered. (M.H.R.)

28180 THEORY OF THE SURFACE OSCILLATIONS OF SUPERFLUID HELIUM IN EQUILIBRIUM WITH ITS SATURATED VAPOR. Seiden, Joseph (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 270: 657-60(9 Mar 1970). (In French).

When $T < 1.1$°K, the influence of the saturated vapor can be neglected. In this case, at low frequencies, the dispersion relation of the surface oscillations of superfluid helium is identical with that of an ordinary liquid. At higher frequencies, the damping of the oscillations is smaller than it is for an ordinary liquid, the frequency of the oscillations varies as a function of the wave vector and small oscillating temperature gradients appear. For $T > 1.1$°K the saturated vapor above the liquid contributes slightly to the damping of the oscillations and modifies their frequency. (France)

28181 NONLOCALIZATION OF THE KONDO STATE IN A KONDO SUPERCONDUCTOR. Culbert, Harvey V. (Argonne National Lab., Ill.); Edelstein, A. S. Solid State Commun.; 8: 445-9(15 Mar 1970).

Specific heat measurements on Kondo alloys Ce_xLa_{1-x} in the superconducting state show the existence of a γT term that is linear in Ce concentration for $0.0075 \geq x \geq 0.002$. The magnitude of γ is in agreement with the prediction based on previous electron tunneling measurements. There is a critical concentration ($x \approx 0.001$) below which there is an energy gap; i.e., $\gamma = 0$. This implies that a single impurity cannot locally destroy the energy gap. (auth) (UK)

28182 TURBULENT DYNAMO ACTION AT LOW MAGNETIC REYNOLDS NUMBER. Moffatt, H. K. (Cambridge Univ., Eng.). J. Fluid Mech.; 41: 435-52(Apr 1970).

The effect of turbulence on a magnetic field whose length scale L is initially large compared with the scale l of the turbulence is considered. There are no external sources for the field, and in the absence of turbulence it decays by ohmic dissipation. It is assumed that the magnetic Reynolds number $R_m = u_0 l/\lambda$ (where u_0 is the root-mean-square velocity and λ the magnetic diffusivity) is small. It is shown that, to lowest order in the small quantities l/L and R_m, isotropic turbulence has no effect on the large-scale field; but that turbulence that lacks reflexional symmetry is capable of amplifying Fourier components of the field on length scales of order $R_m^{\frac{1}{2}}l$ and greater. In the case of turbulence whose statistical properties are invariant under rotation of the axes of reference, but not under reflexions in a point, it is shown that the magnetic energy density of a magnetic field which is initially a homogeneous random function of position with a particularly simple spectrum ultimately increases as $t^{-\frac{1}{2}}\exp(\alpha^2 t/2\lambda^3)$ where $\alpha (= O(u_0^2 l))$ is a certain linear functional of the spectrum tensor of the turbulence. An analogous result is obtained for an initially localized field. (auth) (UK)

28183 A HIGH-PRESSURE ANVIL USED FOR AC MAGNETIC SUSCEPTIBILITY MEASUREMENT AT LOW TEMPERATURE. Nakajima, Tetsuo; Kanda, Eizo (Tohoku Univ., Sendai). Jap. J. Appl. Phys.; 9: 425-6(Apr 1970).

A cryogenic force intensifier is described which is a modification of the ice bomb technique used by Brandt et al. Some parts are made of hardened Cu–Be alloy. The ac magnetic susceptibility is measured by an ac mutual inductance bridge. High-density alumina is used as the anvil material. Superconducting transitions in tin specimens at different pressures are shown. (D.L.C.)

28184 SUPERCONDUCTIVITY AND LATTICE PARAMETERS IN THE ZIRCONIUM–MOLYBDENUM, ZIRCONIUM–TUNGSTEN, HAFNIUM–MOLYBDENUM, AND HAFNIUM–TUNGSTEN ALLOY SYSTEMS. Rapp, Oesten (Univ. of California, San Diego, La Jolla). J. Less-Common Metals; 21: 27-44(1970).

Superconductivity and lattice parameters have been measured on annealed alloys of $ZrMo_2$, ZrW_2, $HfMo_2$, and HfW_2. Polymorphism for $HfMo_2$ was reconfirmed and the compound was found to be superconducting at 0.07°K in the C15 structure and normal down to 0.05°K in the C36 modification. The C15 compounds $ZrMo_2$, ZrW_2, and HfW_2 were normal down to at least 1.2°K. The bcc phase was investigated by rapid quenching from the melt. It was possible to obtain single-phase bcc alloys in the range 3–41 at.% Mo in Zr–Mo alloys and about 9 to at least 67 at.% Mo in Hf–Mo alloys. The lattice parameters at room temperature for these alloys could be accurately determined and extrapolated to room temperature bcc values for Zr and Hf. It was possible to obtain $HfMo_2$ alloys in three different crystals structures. The superconducting transition temperature is about 1°K for the bcc modification and decreases with decreasing lattice symmetry. The rapid quenching technique was less successful in the tungsten alloys, but superconductivity in the bcc phase could be observed in all four alloy systems. A maximum in the transition temperature was found in all systems at an electron-atom ratio between 4 and 5. In the Zr–W system, a dip in the transition temperature versus concentration was observed at the composition of the compound ZrW_2. Some aspects of the superconductivity in the bcc phase are discussed. It is found that the rigid band model is a good approximation in the dilute Zr region. An extrapolation to bcc Zr gives 1.5°K as the estimate for the transition temperature. (auth)

28185 RIGOROUSLY SOLVABLE MODEL OF A MAGNETIC ION IN A SUPERCONDUCTOR. Bernasconi, J.; Straessler, S. (Brown Boveri Research Center, Baden, Switzerland). Helv. Phys. Acta; 43: 307-10(15 May 1970).

A magnetic ion, described by the Anderson Hamiltonian, is coupled to a strong-coupling superconductor (kinetic energy is neglected). Exact conditions for the magnetic state are derived. (auth)

28186 A CRYOSTAT DESIGN FOR RADIATION DAMAGE EXPERIMENTS AT LOW TEMPERATURE. Bourgoin, J.; Zizine, J.; Squelard, S.; Baruch, P. (Univ., Paris). Radiat. Eff.; 2: 287-9(Mar 1970).

A cryostat for electron irradiations at liquid hydrogen or helium

temperatures is described. The cryostat uses two concentric liquid coolant containers, of which the inner reservoir is sealed and acts as a heat exchanger through ebullition and recondensation of the coolant gas. This allows irradiations with a power input from the beam of up to a few watts, and when the sample is thermally isolated allows it to be annealed up to room temperature. (auth)

28187 DESIGN AND OPERATION OF STABLE rf-BIASED SUPERCONDUCTING POINT-CONTACT QUANTUM DEVICES, AND A NOTE ON THE PROPERTIES OF PERFECTLY CLEAN METAL CONTACTS. Zimmerman, J. E.; Thiene, Paul; Harding, J. T. (Philco-Ford Corp., Newport Beach, Calif.). J. Appl. Phys.; 41: 1572-80(15 Mar 1970).

Point-contact devices are described which have exhibited long-term stability and reliability. A particular mode of operation of the devices as rf-biased low-frequency detectors is described in detail, including a description of how the device drives a resonant circuit to which it is coupled. In this mode of operation the sensitivity of the devices to low-frequency fields is of the order of 10^{-9} G per root cycle bandwidth. Perfectly clean contacts were made by breaking a notched niobium member at 4.2°K and then remaking contact at the break. Quantum behavior of such contacts is identical to that of ordinary contacts, but effects of microscopic multiple connections at the contact were not observed. (auth)

28188 LIQUID HELIUM CRYOSTAT FOR NEUTRON DIFFRACTION STUDIES. Leciejewicz, Janusz; Ler, Boguslaw; Murasik, Andrzej; Skoczek, Ksawery (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 14: 843-5(1969).

The liquid helium cryostat for the neutron-diffraction investigation of magnetic materials is described. It makes it possible to obtain neutron-diffraction patterns of single crystals and polycrystalline samples at liquid helium, liquid hydrogen, and liquid nitrogen temperatures with the same specimen mounting. There is no scattering of neutrons by the cooling liquids which, in the case of H_2 and N_2, would give rise to a very high instrumental background. A schematic drawing of the cryostat is shown and explained. (M.H.R.)

28189 CRYOGENICS AND NUCLEAR PHYSICS. PART 1. Hammel, E. F.; Rogers, J. D. (Los Alamos Scientific Lab., N. Mex.). Cryogenics; 10: 5-14(Feb 1970).

This is the first part of a two part review on the relationship between cryogenics and nuclear physics. A brief introduction listing the five main areas in which the two subjects meet (targets, beam handling, particle detectors, neutron moderators and interaction between radiation and condensed matter) is followed by a review of their relationship over the past thirty years. The first part then concludes with a discussion of the first main area of mutual interest—targets and targets using oriented nuclei. (UK) (auth)

28190 SUPERCONDUCTIVITY OF BARIUM AT HIGH PRESSURES. Il'ina, M. A.; Itskevich, E. S. (Inst. of High-Pressure Physics, Moscow). JETP Lett. (USSR)(Engl. Transl.); 11: 15-17(5 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu; 11: 26-8(5 Jan 1970).

The superconducting transition of Ba was investigated at pressures of 60 to 100 kbar. At pressures of 85 and 88 kbar, the transition occurred at 1.55°K and 3.05°K, respectively, but further increases of pressure result in decrease of T_c. Similar observations on the high-pressure phase of Sb agree with the literature. (D.L.C.)

28191 MAGNETIC PROBLEMS OCCURRING AT SUPERCONDUCTIVITY. Fahlenbrach, H. Metall; 24: 22-8(Jan 1970). (In German).

The differing magnetic properties and the various types of superconductors are explained and the results of the pertinent theories are described. It is shown that the magnetic phenomena are of significance in the superconductivity of all types. Parallel phenomena of basic or formal types are indicated in ferro- or ferrimagnetism. The area of hard superconductors remains the focus of research and development with special consideration of their possible industrial applications. (tr-auth)

28192 TEMPERATURE DEPENDENCE OF THE CRITICAL MAGNETIC FIELD OF SUPERCONDUCTORS. Nowotny, H.; Hittmair, O. (Technische Hochschule, Vienna). Phys. Lett.; 31A: 372-3(6 Apr 1970).

The deviation of the reduced critical field from the law of corresponding states may be obtained by a simple model for the frequency dependence of the energy gap. The significant parameter for different superconductors is T_c/θ_D. (auth)

28193 UPPER CRITICAL FIELDS OF HIGH-TEMPERATURE SUPERCONDUCTING $Nb_{1-y}(Al_{1-x}Ge_x)_y$ AND Nb_3Al: MEASUREMENTS OF $H_{c2} > 400$ kG AT 4.2°K. Foner, S. (Massachusetts Inst. of Tech., Cambridge); McNiff, E. J. Jr.; Matthias, B. T.; Geballe, T. H.; Willens, R. H.; Corenzwit, E. Phys. Lett.; 31A: 349-50(6 Apr 1970).

Pulsed field measurements of the upper critical fields at 4.2°K, H_{c2} (4.2°K), in $Nb_{1-y}(Al_{1-x}Ge_x)_y$ and Nb_3Al are approximately 410 and 295 kG, respectively. The data are consistent with complete suppression of Pauli paramagnetic limiting. (auth)

28194 THEORY OF SURFACE OSCILLATIONS OF SUPERFLUID HELIUM AT HIGH FREQUENCIES. Seiden, Joseph (Institut d'Electronique Fondamentale, Essone, France). Compt. Rend., Ser. B; 269: 1138-41(3 Dec 1969). (In French).

The hydrodynamic study of surface oscillations of helium II in the general case is considered. A description of the model, two-dimensional modes of oscillation of the superfluid helium, frequency, limiting conditions, and surface oscillations are discussed. It is seen that this study confirms, qualitatively, some previous results. (J.F.P.)

28195 ELECTROMAGNETIC WAVE PROPAGATION IN A SUPERCONDUCTING GUIDE. Zepp, Gerard (Laboratoire de Physique Theorique, Clermont-Ferrand, France). Compt. Rend., Ser. B; 269: 1030-3(17 Nov 1969). (In French).

The guided propagation of a TE_n-mode wave and a TM_n-mode wave between two superconducting media of the same kind and bound by plane parallel surfaces is studied, taking into account the nonlocal character of the normal and superconducting currents. (tr-auth)

28196 OSCILLATION DAMPING AT THE SURFACE OF SUPERFLUID HELIUM. Seiden, Joseph (Institut d'Electronique Fondamentale, Orsay, France). Compt. Rend., Ser. B; 269: 1013-16(17 Nov 1969). (In French).

In this study of the surface oscillations of superfluid helium, certain previous restrictions are omitted since the validity of the second inequality is not postulated. It is shown that the damping of surface oscillations, contrary to the case of ordinary liquids, is strongly affected in the superfluid state by the coefficients of the second viscosity. (J.F.P.)

28197 SINGULARITIES OF THE RESISTIVE STATE WITH CURRENT IN THIN SUPERCONDUCTING FILMS. Gor'kov, L. P. (Inst. of Theoretical Physics, Moscow). JETP Lett. (USSR)(Engl. Transl.); 11: 32-5(5 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu; 11: 52-6(5 Jan 1970).

A qualitative description is given of the nonlinear current–voltage characteristic of a superconducting film. A diagram of the current connected with the fluctuations is drawn that makes it possible to obtain directly a gauge-invariant expression for the current increment. It is shown that the current–voltage characteristic has a section corresponding to negative differential conductivity. (D.L.C.)

28198 NUCLEAR COOLING IN $PrPt_5$ AND $PrTl_3$ TO BELOW 5 mdeg K. Andres, K.; Bucher, E. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 24: 1181-4(25 May 1970).

Nuclear adiabatic demagnetization experiments have been carried out on the Van Vleck paramagnets $PrPt_5$ and $PrTl_3$. Starting from 60 millidegrees K and 20 kOe, end temperatures of 5 and 3 millidegrees K, respectively, are obtained. In $PrPt_5$, the end temperature seems to be limited by a residual nuclear level splitting due to the hexagonal structure. No sign of a nuclear ordering phenomenon can be detected in $PrTl_3$ down to 3 millidegrees K. The suitability of these materials for magnetic cooling purposes is pointed out. (auth)

28199 FREE ENERGY FUNCTIONAL AND BOGOLYUBOV EQUATIONS. Cyrot, M. (Faculte des Sciences, Orsay, France). J. Low Temp. Phys.; 2: 195-8(Mar 1970).

By using a functional integral formulation of the theory of superconductivity, a generalization of the Ginsburg–Landau free energy functional valid at all temperatures is derived. It reduces to it near the critical temperature. By minimization of this new functional, the usual Bogolyubov self-consistent equations for superconductors are obtained. (auth)

28200 DYNAMICAL PROPERTIES OF GAPLESS SUPERCONDUCTORS. Gor'kov, L. P.; Eliashberg, G. M. (Inst. of Theoretical Physics, Moscow). J. Low Temp. Phys.; 2: 161-72 (Mar 1970).

The system of time-dependent equations is obtained for superconductors in the gapless region (strong magnetic fields). The thin films in a presence of uhf power are considered in more de-

tail. It is shown that the whole picture is very different in comparison with the simple diffusion-type extension of the Ginsburg–Landau theory. It is pointed out that a new characteristic time has to be introduced corresponding to processes of the energy relaxation. (auth)

28201 ROLE OF ELECTRON BUBBLES ON LASER-INDUCED BREAKDOWN IN LIQUID ^{4}He. Silver, M.; Hernandez, J. P.; Onn, D. G. (Univ. of North Carolina, Chapel Hill). Phys. Rev., A; 1: 1268-70(Apr 1970).

Recent experimental results on laser-induced breakdown of liquid ^{4}He have been interpreted by assuming that unbound electrons collide mainly with thermal rotons between the λ temperature and 1.5°K. Previous experimental results on the behavior of hot electrons injected into liquid helium suggest that the collision frequency ν of the unbound electrons and their lifetime τ before they are trapped into bubbles are relatively temperature-independent between 4.2 and 1.35°K, in contrast to the above-mentioned assumption. An alternative explanation is offered to the recent results based on an assumed temperature-dependent ejection of electrons from the bubbles. (auth)

28202 SUPERCONDUCTIVITY OF AN α–URANIUM SINGLE CRYSTAL UNDER PRESSURE. Palmy, C. (Swiss Federal Inst. of Tech., Zurich); Fisher, E. S. Solid State Commun.; 8: 655-7 (Apr 1970).

A large positive, reversible pressure dependence of dT_c/dp = 0.18° K/bar was observed for an α-U single crystal in the pressure range between zero and 8 kbar. Magnetization measurements were made for the whole pressure range. (auth) (UK)

28203 EFFECT OF HYDROSTATIC PRESSURE ON THE LOW-TEMPERATURE PHASE TRANSITION IN ALPHA–URANIUM. Fisher, E. S.; Dever, D. (Argonne National Lab., Ill.). Solid State Commun.; 8: 649-53(Apr 1970).

Measurements of single-crystal elastic moduli of uranium at low temperatures and hydrostatic helium pressures to 4 kbar show that $dT_\alpha/dP = -3.4$°K/kbar, where T_α is the temperature of the phase transition that occurs at 42 ± 1°K at 1 bar. Extrapolation of the data indicates that $T_{c,max}$, for superconductivity in uranium corresponds to T_α at 11.5 kbar. This result supports the concept that $dT_c/dP > 0$ in uranium is a result of the phase transition. (auth) (UK)

28204 SUPERHEATING AND SUPERCOOLING BY DC MEASUREMENTS IN A BULK SUPERCONDUCTOR. Deltour, R. (Univ. Libre, Brussels); De Lang, H. N.; Wyder, P. Phys. Lett.; 31A: 515-16(4 May 1970).

It is possible to observe superheating and supercooling in macroscopic bulk cylinders of pure type-I indium in the intermediate state geometry by simple dc-resistance measurements. (auth)

28205 CALCULATION OF THE CRITICAL CURRENT FOR TYPE-II SUPERCONDUCTING WIRES IN LONGITUDINAL FIELDS. LeBlanc, M. A. R.; Kiggins, B. R. (Univ. of Ottawa). Solid State Commun.; 8: 633-7(Apr 1970).

Calculations based on the critical-state concept are presented and show that the humped shape of I_c vs. $H_{||}$ curves observed in wires of nonideal type-II superconductors is due in part to the magnetic field dependence of the pinning force density. (auth) (UK)

28206 EFFECT OF PRESSURE ON SUPERCONDUCTING TRANSITION TEMPERATURE OF LEAD. Rajput, J. S. (Banaras Hindu Univ., India). Solid State Commun.; 8: 711-12(May 1970).

A simple method to determine the variation of superconducting transition temperature with pressure for simple metal superconductors is presented. Results were obtained and are discussed for the case of lead. (auth) (UK)

28207 PENETRATION DEPTH OF AN ELECTROMAGNETIC FIELD IN A TYPE-I SUPERCONDUCTING MEDIUM. Zepp, Gerard (Clermont-Ferrand Univ., France). Compt. Rend., Ser. B; 270: 785-7(23 Mar 1970). (In French).

The variation of the penetration depth λ of a variable field in a massive sample of a Type-I superconductor, with the frequency and the various parameters characterizing the superconductor, is studied. Different cases are considered, in particular, the limiting case for which the frequency is equal to zero (static field). The theoretical results are in agreement with the experimental values. (FRANCE)

28208 THIRD LAW AND THE BEHAVIOR OF MATTER NEAR ABSOLUTE ZERO. pp 63–82 of Thermodynamics and Statistical Physics. /Finkelstein, Robert J. San Francisco; W. H. Freeman and Co. (1969).

After a qualitative description of the behavior of matter near absolute zero in terms of disorder and quantum mechanics, superfluidity (liquid He) and superconductivity are discussed. The thermodynamics of transition are considered, and London equations are derived. Quantization of magnetic flux and microscopic theory of superconductors are discussed. The experimental basis and unattainability formulation of the third law are given. (D.L.C.)

28209 INJECTON AND MOBILITY OF POTASSIUM IONS IN LIQUID HELIUM. Ihas, G. G.; Sanders, T. M. Jr. (Univ. of Michigan, Ann Arbor). Phys. Lett.; 31A: 502-3(4 May 1970).

Potassium ions from a hot tungsten wire are injected into He II; their mobility is found to be two to three % lower than that of "normal" positive ions. (auth)

28210 EVIDENCE FOR A SUPERFLUID-INDUCED SURFACE BARRIER FOR ELECTRONS IN LIQUID HELIUM. Schoepe, W. (Technische Hochschule, Munich); Probst, C. Phys. Lett.; 31A: 490-1(4 May 1970).

The free surface of liquid helium acts as an energy barrier on electron currents across the surface into the vapor if the liquid is superfluid. In a zero electric field, the barrier vanishes at T_λ. The measurements were performed in pure ^{4}He and in a solution of ^{3}He in ^{4}He. (auth)

28211 THE MICROSCOPIC DERIVATION OF THE QUANTUM-HYDRODYNAMICAL MODEL FOR A DILUTE SOLUTION OF IMPURITIES IN SUPERFLUID HELIUM. Winter, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Phys. Lett.; 31A: 489-90(4 May 1970).

The quantum-hydrodynamical model for dilute solutions of impurities in superfluid helium is derived microscopically, starting with a particle Hamiltonian. (auth)

28212 ENERGY GAP OF THE LOWER BAND OF SUPERCONDUCTING NIOBIUM AT T = 0°K. Tang, I. M. (Reed Coll., Portland, Oreg.). Phys. Lett.; 31A: 480-1(4 May 1970).

It is seen that the discrepancy between the values of the lower band energy gap at T = 0°K of superconducting niobium obtained from recent thermal conductivity measurements and those previously obtained is due to the neglect of the interband coupling g_{sd}. (auth)

28213 HETEROGENEOUS DEFORMATION OF NIOBIUM SINGLE CRYSTALS AT VERY LOW TEMPERATURES. Kubin, Pierre; Jouffrey, Bernard (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 270: 812-14(23 Mar 1970). (In French).

At temperatures of about 4.2°K, the energy release during the plastic deformation may lead to a stress instability. The thermal origin of this instability is revealed, for niobium, by the comparison between the deformation curves obtained in the normal and the superconducting states. (France)

28214 EVIDENCE FOR THE ELECTRON–PHONON INTERACTION IN THE SUPERCONDUCTIVITY OF A TRANSITION METAL: TANTALUM. Shen, L. Y. L. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 24: 1104-7(18 May 1970).

The phonon density of states of tantalum is obtained from electron tunneling measurements. The data, analyzed using techniques based on the electron–phonon theory of superconductivity, demonstrate that no alternative electron–electron coupling mechanism is needed to understand the superconductivity of this transition metal. (auth)

28215 USE OF BULK SINTERED SUPERCONDUCTORS TO GENERATE HIGH MAGNETIC FIELDS. Williams, M. J. Sci. Technol. (London); 36: No. 2, 93-8(1969).

The use of bulk Nb_3Sn sintered powder for superconducting devices is discussed with special reference to its use for permanently magnetized tubes. Flux trapped in a superconducting tube is permanently compressed if the bore area is reduced by insertion of a superconducting piston. (Metals Abstr.)

28216 FILM SUPERCONDUCTIVITY STIMULATED BY A HIGH-FREQUENCY FIELD. Eliashberg, G. M. (Inst. of Theoretical Physics, Moscow). JETP Lett. (USSR)(Engl. Transl.); 11: 114-16(5 Feb 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 186-8 (5 Feb 1970).

It is shown that the destruction of superconductivity in small-size samples by an alternating electromagnetic field occurs only for frequencies below a critical value ω_c; when $\omega > \omega_c$, the field should increase the ordering parameter. Equations are derived, and some of the singularities of the superconducting state stimulated by an ac field are listed: a maximum exists with $T > T_c$; the stability of the state is not known; and the critical current is increased. (D.L.C.)

28217 SURFACE-DEPENDENT GEOMETRICAL RESONANCE OF SUPERCONDUCTORS. Schattke, W. (Univ., Kiel). Z. Naturforsch.; 25a: 189-95(Feb 1970).

The nonlocal integral equation obtained previously allows the determination of the amplitude of geometrical resonances in the McMillan–Anderson model. Surface conditions are defined by an adjustable parameter p, which is fixed to fit the critical thickness measurements of the proximity effect. (auth)

28218 EFFECT OF INHOMOGENEITIES ON THE STRUCTURE OF THE MIXED STATE OF SUPERCONDUCTORS. Larkin, A. I. (Landau Inst. of Theoretical Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 58: 1466-70(Apr 1970). (In Russian).

A phenomenological model is proposed that can be employed for describing the influence of defects on the structure of a mixed superconducting state. Defects lead to disappearance of long-range order in the arrangement of the vortex lines. The correlation function for displacement of the vortices from their ordered arrangement is found. The dimensions of the region in which short-range order exists are estimated. (auth)

28219 QUASI-TWO-DIMENSIONAL NATURE OF THE SUPERCONDUCTIVITY OF $NbSe_2$. Kats, E. I. (Landau Inst. of Theoretical Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 58: 1471-4(Apr 1970). (In Russian).

The experimental data are compared with the theory of lamellar structures. For stoichiometric samples the agreement is good. On deviation from stoichiometry, a detailed comparison is difficult because of absence of data on the angular dependence of the mean free path and on variation of the crystal structure. (auth)

28220 INTERNAL GRAVITATIONAL WAVES IN A SUPERFLUID SOLUTION. Parshin, A. Ya. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.); 10: 362-4(20 Dec 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 567-70(5 Dec 1969).

It is known that internal gravitational waves can propagate in ordinary liquids as a result of inhomogeneity of the liquid in the gravitational field. For such waves to exist it is necessary that the thermal equilibrium be established much more slowly than the mechanical equilibrium. It is clear that no such phenomenon can exist in superfluid helium, in which this requirement is not satisfied; any disturbance of the equilibrium can lead only to waves of first or second sound. A superfluid solution is analogous in a certain sense to an ordinary liquid, in that a temperature gradient can be produced in it under stationary conditions. It is shown that gravitational waves can also exist in such a solution. The conditions for mechanical equilibrium of a superfluid solution in gravitational waves are derived. (M.H.R.)

28221 SUPERCONDUCTIVITY IN LAYERED STRUCTURE ORGANOMETALLIC CRYSTALS. Gamble, F. R. (Synvar Research Inst., Palo Alto, Calif.); DiSalvo, F. J.; Klemm, R. A.; Geballe, T. H. Science; 168: 568-70(1 May 1970).

Superconductivity persists in several, layered, transition metal dichalcogenide superconductors when the layers are spread apart to accommodate organic molecules between them. These materials are of interest not only because of their two-dimensional character but also because they may provide a means for examining hypotheses regarding organic molecules and superconductivity. (auth)

Plasma and Thermonuclear Physics

Refer also to abstract 27470.

28222 PLASMA PHYSICS INDEX. VOLUME 5, NO. 1, 1970. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 74p.

This listing includes 314 articles on various aspects of plasma physics. (M.O.W.)

28223 PLASMA PHYSICS INDEX. VOLUME 5, NO. 3, 1970. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 101p.

This listing includes 450 articles on various aspects of plasma physics. (M.O.W.)

Confinement and Heating

Refer also to abstracts 28262 and 28338.

28224 (MATT-756) ANOMALOUS HIGH-FREQUENCY RESISTIVITY AND HEATING OF A PLASMA. Kruer, W. L.; Kaw, P. K.; Dawson, J. M.; Oberman, C. (Princeton Univ., N. J. Plasma Physics Lab.). Mar 1970. Contract AT(30-1)-1238. 14p. Dep. CFSTI.

Computer experiments were carried out on the anomalous heating of a one-dimensional plasma by a large-amplitude long-wavelength electric field oscillating near the plasma frequency. Above a certain threshold the large driver field excites an instability in the plasma and drives up ion-density fluctuations as well as plasma oscillations. When the ion fluctuations reach a sufficiently large level, the plasma begins to heat very efficiently according to an anomalous resistivity. An effective collision frequency as high as 0.2 ω_{pe} was observed. A theoretical explanation of the observed results is given. (auth)

28225 CYCLOTRON HEATING DUE TO A MODULATED ELECTRON BEAM IN A MIRROR MACHINE. Lopez, O. (Yale Univ., New Haven); Siambis, J. G. Plasma Phys.; 11: 681-4 (Aug 1969).

This note presents results of a numerical study of the variation of the kinetic energy, magnetic moment and longitudinal invariant of a charged particle trapped in a dc mirror magnetic field and acted upon by a radial rf electric field with frequency nearly equal to the cyclotron frequency of the charged particle. (auth) (UK)

28226 CHARGE CARRIER AND ENERGY LOSSES OF A MAGNETIC MIRROR MACHINE DUE TO COULOMB SCATTERING AND THE CONDITION FOR SELF-SUSTAINING OF A NUCLEAR FUSION REACTOR. Valentini, H.-B. (Institut fuer Magnetohydrodynamik, Jena, Ger.). Kernenergie; 13: 33-40(Feb 1970). (In German)

The charge carrier losses caused by Coulomb scattering and the energy losses in connection with this from a steady-state mirror machine were calculated in diffusion approximation for high mirror ratio provided that a Maxwell distribution of the magnitudes of the ion and electron speeds is fulfilled. Coulomb collisions between ions of different sorts were taken into account. The time constant of scattering in direction and the mean confinement periods of the different ions presents in a fusion plasma, and, moreover, plasma potential and the mean energies of escaping particles for various sorts of ions and electrons were determined. In D–D reactors, the energy losses of a fusion plasma in a mirror machine of mirror ratio 10 have a minimum for ion temperatures of some 100 keV. The range of optimum ion temperature for fusion is determined by the energy losses due to escaping charge carriers and the power generated in the nuclear reactions. The bremsstrahlung losses are of no consequence. If cyclotron radiation losses are neglected, the electron temperature was found to be about a quarter of ion temperature. The condition for self-sustaining of a fusion reaction in mirror geometry can only be fulfilled even under very favorable conditions if fuel heating is realized with an efficiency of at least 55 to 75% in D–D reactors and of about 30% in D–T reactors. (auth)

28227 ENERGY CONFINEMENT TIME OF A PLASMA AS A FUNCTION OF THE DISCHARGE PARAMETERS IN TOKAMAK-3. Gorbunov, E. P.; Mirnov, S. V.; Strelkov, V. S. (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion; 10: 43-51(Mar 1970).

The thermal insulation of plasmas in Tokamak-3 was investigated, taking as a thermal-insulation parameter the energy confinement time of the plasma τ_E and relating it to the discharge parameters: the stabilizing magnetic field H_z, the charged particle density n_e and the discharge current I. It is found that for $n_e \geq 2 \times 10^{13}$ cm^{-3} τ_E is virtually independent of H_z, while for n_e = (1 to 5) $\times 10^{13}$ cm^{-3} τ_E increases somewhat with n_e and in proportion to I. The experimental results fit the empirical formula $\tau_E \sim a^2 H_\phi$. (auth)

28228 PASSAGE OF AN INTENSE RELATIVISTIC ELECTRON BEAM THROUGH A CUSPED MAGNETIC FIELD. Friedman, Moshe (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 24: 1098-1100(18 May 1970).

Results are presented of the injection of a high-intensity, high-current, relativistic electron beam into a cusped magnetic field. 10^{14} electrons are passed through the cusp. Preliminary observations indicate that these electrons produce a "cloud" of relativistic electrons gyrating in a magnetic field and having a small ratio of translational to rotational energies. (auth)

28229 ELECTRON CYCLOTRON RESONANCE HEATING IN A Q MACHINE. Soures, J.; Lubin, M. J. (Univ. of Rochester, N. Y.). Phys. Fluids; 13: 1648-50(Jun 1970).

An experimental method of achieving ratios of $T_e/T_i > 10$ in a single-ended Q machine, utilizing pulsed x-band microwave power, is presented. (auth)

28230 SINGLE-PARTICLE DIFFUSION DUE TO MAGNETICALLY GUARDED HANGERS IN A TOROIDAL OCTUPOLE. Erickson, C. W. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Phys. Fluids; 13: 1646-8(Jun 1970).

Scattering of single particles by field perturbations due to magnetically guarded hangers may cause losses to walls and hoops commensurate with losses to unshielded supports. (auth)

28231 BEHAVIOR OF A COLD ION PLASMA IN A TOROIDAL OCTUPOLE. Sprott, J. C. (Univ. of Wisconsin, Madison). Phys. Fluids; 13: 1626-33(Jun 1970).

By raising the background hydrogen gas pressure to ~10^{-4} torr and injecting 10 to 100 kW of 700- to 9000-MHz microwave power for ~100 μsec, an afterglow plasma with $n \sim 10^9$ to 10^{11} cm^{-3} and $kT_i < kT_e \sim 1$ eV can be produced in the Wisconsin toroidal octupole. The particle lifetime is ~3 msec, or somewhat longer than for a hot ion, gun injected plasma, and most (~80%) of the plasma is lost to the hoops. The electron temperature decays rapidly as a result of inelastic electron–neutral collisions. By changing the magnetic field strength and microwave frequency, the density distribution can be varied, and a variety of fluctuations produced. These fluctuations do not appear to be an important source of plasma loss. (auth)

28232 EQUILIBRIUM DIFFUSION IN A TOROIDAL RESISTIVE PLASMA. Stringer, T. E. (Culham Lab., Abingdon, Eng.). Phys. Fluids; 13: 1586-95(Jun 1970).

The equilibrium equations are solved, including resistivity, parallel viscosity, and a radial electric field. A resonance effect occurs when the frequency of the electric rotation about the minor axis approaches the frequency of a natural plasma mode. For arbitrary steady electric fields the ion and electron diffusion rates are unequal, and the space charge inevitably builds up until the two rates equalize. In most conditions of interest, this ambipolar electric field is close to the resonance value, and the ambipolar diffusion rate is much larger than the Pfirsch and Schlüter rate. (auth)

28233 TURBULENT HEATING OF A PLASMA IN A DISCHARGE WITH A SKIN CURRENT. Dubovoi, L. V.; Fedyakova, V. P. Zh. Eksp. Teor. Fiz.; 58: 1168-77(Apr 1970). (In Russian).

Results of an experimental investigation of the efficiency of heating of a plasma in a high-frequency discharge with a skin current in the turbulent state are presented. A scheme for calculating the heating efficiency of a plasma is proposed for the case when ion–acoustic instability is excited in the region of the skin layer; discharge current dissipation in the plasma in the turbulent state and transfer phenomena occurring perpendicular to the external field and accompanied by dissipation of the high frequency field energy are taken into account. The applicability of the concepts developed in work on high-frequency discharges to turbulent heating of a plasma by single short-duration current pulses is discussed. (auth)

Diagnostics

Refer also to abstract 28271.

28234 (AD-691254) MEASUREMENT OF THE ELECTRICAL CONDUCTIVITY OF XENON IN A SHOCK TUBE. Zauderer, B. (General Electric Co., Philadelphia, Pa. Space Div.). Jul 1969. Contract Nonr-3867(00). 17p. (TR-13). CFSTI.

The electric conductivity of xenon was measured in a shock tube at gas pressures of about one atmosphere and in the temperature range of 5500 to 9000°K. Where ionization equilibrium was achieved immediately behind the shock front, the experimental conductivities were in agreement with the theoretical analyses based on either the Boltzmann equation or the Fokker–Planck equation. At Mach numbers below 8, ionization equilibrium was not always achieved and considerable uncertainty exists in correlating the measured conductivity to known gas properties. (auth) (USGRDR)

28235 (AD-701669) LANGMUIR PROBE DIAGNOSTICS OF FLUCTUATION IN A REFLEX ARC NITROGEN PLASMA. Haycraft, Thomas James (Naval Postgraduate School, Monterey, Calif.). Jul 1969. 58p. CFSTI.

Thesis.

A reflex arc nitrogen plasma in a longitudinal magnetic field was investigated by means of cylindrical Langmuir probes. Magnetic fields varying from 2400 to 6600 G were studied. A radial profile of electron temperature and space potential was obtained as an aid to understanding the inner and outer rotational fluctuations previously noted to be characteristic of the reflex arc column. The effect of crossed magnetic and electric fields resulting in E × B particle drift is proposed as the primary mechanism of the outer rotational fluctuation, while the inner rotation mechanism is proposed to be the j × B force of the magnetohydrostatic equation of a plasma in equilibrium. (auth) (USGRDR)

28236 (CLM-R-102) MASS ANALYSER FOR USE IN MAGNETICALLY CONFINED PLASMA STREAMS. Ashby, D. E. T. F.; Burcham, J. N.; Chambers, R. G. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Nov 1969. 5p. Dep. CFSTI (U. S. Sales Only). UK 1s. 2d.

A time-of-flight analyzer was designed to measure the charge/mass ratio of the ions of a plasma streaming in a uniform parallel magnetic field. The analyzer was tested in plasmas of number density 10^{10} to 10^{11} cm^{-3}, in which the ions have thermal and streaming energies of about 50 eV. (auth)

28237 (CTO-635) LIGHT SCATTERING AS A PLASMA DIAGNOSTIC TECHNIQUE. Dushin, L. A.; Pavlichenko, O. S. Translated by L. C. Ronson (Culham Lab., Abingdon, Eng.), from pp 96-143 of Issledovanie Plazmy s Pomoshch'yu Lazerov, Atomizdat, Moscow, 1968. 39p. Dep. CFSTI (U. S. Sales Only).

Laser methods for studying plasmas were surveyed. Data are given for some of the various techniques involved. The bibliography, which contains about 200 references, is not included but will be issued as a supplement. (M.O.W.)

28238 RADIO-FREQUENCY OBSERVATIONS IN THE NEW ASTRON TANKS. Stallard, B. W.; Weiss, P. B. (Univ. of California, Livermore). Plasma Phys.; 11: 779-83(Sep 1969).

Measurements were made of the rf spectrum occurring upon beam injection into the new Astron geometry. These measurements were made as part of attempts to understand the mechanisms occurring during formation of the E layer. Observations over a range of experimental parameters show that the spectrum has a consistent structure. The dominant features appear to be tank resonant modes excited by the beam and narrow-band signals occurring near harmonics of the relativistic cyclotron frequency. These latter signals are possibly attributable to the negative mass instability. (auth) (UK)

28239 RADIO-FREQUENCY FLOATING DOUBLE PROBE AS A PLASMA DIAGNOSTIC. Oliver, B. M.; Clements, R. M. (Univ. of Victoria, B. C.). J. Appl. Phys.; 41: 2117-22(Apr 1970).

A floating double probe operating at radio frequencies in the MHz range was developed to the point where measurements of sheath capacitance and resistance yield values for plasma ionization density and electron temperature with an accuracy of ≈8% and ≈16%, respectively. The experimental technique used supersedes previous methods in that it enables sheath capacities as low as 10^{-1} pF to be measured. The analysis of the results was extended to cover the important nonplanar (cylindrical) sheath case. As a result of these two developments, the technique is now applicable to small diameter probes that are essential for measurements in most gas discharge plasmas. The performance of the probes was checked over a range of plasma densities and working frequencies and found to give results in good agreement with microwave-cavity and dc-probe measurements. This type of measurement has various advantages over the usual dc probe methods in terms of complete isolation, but it is expected that its main application will be in situations where the use of the dc probe is suspect due to probe surface contamination effects. (auth)

28240 MONOCHROMATOR MEASUREMENTS OF ION VELOCITIES IN A ROD PLASMA INJECTOR. Kulinski, Stanislaw; Nowikowski, Jerzy; Suckewer, Szymon (Inst. of Nuclear Research, Warsaw). Nukleonika; 14: 1037-45(Oct 1969).

The axial speeds of different groups of ions were measured in a rod plasma injector using a monochromator. These measurements showed that the velocities of different groups of ions are practically equal. The average velocity of the ions was about 5.5×10^6 cm/sec for a delay time of gas supply $\tau = 60$ μs, and 3.5×10^6 cm/sec for $\tau = 240$ μs. It was also found that all the groups of ions are mixed in a plasmoid and no ordered pattern, concerning the distribution of ions in the plasmoid, exists. The speed of the plasmoid was also estimated with the aid of ultrafast photography. A reasonably good agreement was observed between the velocities of ions and those of plasmoids. The results obtained are discussed and an attempt is made to find a suitable explanation. (auth)

28241 OBSERVATIONS ON THE EFFECT OF SURFACE CONDITIONS ON LANGMUIR PROBES. Bunting, W. D. Jr.; Heikkila, W. J. (Univ. of Texas, Dallas). J. Appl. Phys.; 41: 2263-4(Apr 1970).

It was found that reliable Longmuir probe measurements can be obtained if the probe surface is carefully cleaned. The method

found most successful is a discharge cleaning that sputters off the contaminants. Some results of measurements in a cold-cathode discharge in nitrogen are given. (M.O.W.)

28242 REDUCING EXPERIMENTAL LANGMUIR PROBE DATA TO OBTAIN A COMPARISON WITH COLLISIONLESS PROBE THEORY. Battle, E. L.; Bell, R. B. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio). Phys. Fluids; 13: 1488-91(Jun 1970).

The technique developed by Sonin for using the collisionless probe theory of Laframboise to obtain charged-particle number density is here refined and extended to measurements of plasma potential. All necessary curves are given and the technique is applied to the reduction of experimental data taken in a glow discharge in argon in order to illustrate the method. (auth)

28243 ELECTRO-OPTICAL CONVERTER FOR MEASUREMENT OF PLASMA PROPERTIES. Mueller, G.; Raeuchle, E. (Univ., Stuttgart). Z. Naturforsch.; 25a: 296-7(Feb 1970). (In German).

An electro-optical converter is described for disconnecting a measuring circuit. The primary electric signal is converted into an optical signal, which in turn is transformed into a secondary electric signal. The converter consists of an amplifier, a photodiode, a photoconductor, and photoreceiver. The square-wave behavior and the time progression of the probe signal are described. (D.L.C.)

Kinetics (General)

Refer also to abstracts 28352, 28376, and 28459.

28244 (N-70-16988) EXPERIMENTAL AND THEORETICAL INVESTIGATION OF PLASMA RADIATION. Semiannual Status Report, March-August 1969. Griem, Hans R.; Greig, S. R. (Maryland Univ., College Park. Dept. of Physics and Astronomy). [1969]. 5p. (NASA-CR-107794). CFSTI.

Profiles of the Stark-broadened emission lines of Al 1048 and Al 1067 Å were compared with those of Lyman alpha and beta to determine the product of the damping constant and the oscillator strength for each of the argon lines. The truncated profiles of the Lyman alpha and beta lines were also used for temperature measurements based on the relative intensity of the lines. Measurements on the broadening of the neutral helium lines 3889 and 5016 Å were analyzed. Profiles were recorded of the ionized helium resonance line 304 Å. Collective bremsstrahlung from collision-free shock waves was investigated. Profiles for the emission of far infrared radiation from hydrogen gas were determined. (STAR)

28245 OBSERVATION OF PLASMA EFFECTS ON THE SYNCHROTRON EMISSION FROM A HOT ELECTRON PLASMA. Blanken, R. A. (Massachusetts Inst. of Tech., Cambridge. Princeton Univ., N. J.). Phys. Fluids; 13: 1609-16(Jun 1970).

It was observed that the presence of a dense magnetized background plasma can greatly influence the synchrotron emission associated with relativistic electrons. The plasmas studied were produced by electron cyclotron resonance heating in a magnetic mirror geometry. After microwave turnoff, when the background plasma is not present, the usual synchrotron radiation associated with a tenuous distribution of relativistic electrons is observed; during microwave heating when a dense magnetized background plasma is present, the synchrotron intensity may be considerably decreased from the vacuum intensity. The largest decreases are observed at frequencies below the nonrelativistic electron gyrofrequency ω_c, in qualitative agreement with the predictions of a test particle model for the synchrotron emission process. The decreases near $n\omega_c$ are due to the absorption of the synchrotron extraordinary mode via cyclotron damping in the finite-temperature background plasma. At frequencies above the upper hybrid frequency $\omega_{uh}(\omega_{uh}^2 = \omega_p^2 + \omega_c^2)$ the decrease arises because the synchrotron emission occurs into a cutoff mode of the background plasma. (auth)

Kinetics (Experimental)

28246 (COO-1726-42) MEASUREMENT OF PLASMA CONDUCTIVITY FOR ELECTRIC FIELDS LARGER THAN THE RUNAWAY FIELD. Lencioni, D. E. (Wisconsin Univ., Madison. Dept. of Physics). [1969]. 11p. Dep. CFSTI.

The electric conductivity parallel to a magnetic field of a hot-ion hydrogen plasma with $n \simeq 10^9$ cm^{-3}, $T_i \simeq 50$ eV, and $T_e \simeq 5$ eV was measured for electric fields larger than the runaway field. The conductivity was found to be proportional to the plasma density with a value much less than Spitzer's conductivity but larger than Buneman's turbulent conductivity. When the current became comparable to the electron thermal current, the conductivity was found to decrease. (auth)

28247 (IPPJ-87) ENERGY DISPERSION OF POSITIVE IONS EFFUSED FROM AN RF PLASMA. Okamoto, Yukio; Tamagawa, Hajime (Nagoya Univ. (Japan). Inst. of Plasma Physics). Mar 1970. 18p. Dep. CFSTI (U. S. Sales Only).

The energy dispersion for study of the sheath formation and the ion extraction in a rf plasma are measured by extracting the positive ions through a small hole in a metal plane probe and subjecting them to an electrostatic energy analyzer and a quadrupole mass filter. The energy dispersion of positive ions effused from a rf plasma, ΔE, under the assumption that the ion velocity is modulated by a time variation of plasma potential, is theoretically given by $\Delta E \propto (1/\omega)(m/e)^{-} V$, where ω is the rf exciting angular frequency, m/e is the specific ion mass, and V is the maximum amplitude of the time-varying component of the plasma potential, respectively. The theoretical results agree well with the experimental ones. (auth)

28248 (NP-18233) INTERACTION OF RELATIVISTIC ELECTRON BEAMS WITH THE PLASMA AND THE PROBLEM OF CRITICAL CURRENTS. Preprint No. 6. Bogdankevich, L. S.; Rukhadze, A. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1970. 66p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The aim of theoretical studies in the field of electron beam-plasma interactions is the clarification of the critical plasma and beam parameters that cause interaction within a limited system. For this reason, the behavior of an electron beam within an equipotential drift space along the axis of a metallic waveguide was examined. The critical currents that may pass through such a system may be determined on the basis of the stability conditions of the electron beam, or its passage through the compensation ionic background or through the more dense portions of the plasma; this required a more detailed study of the beam stability. The investigation involved an examination of the boundary currents in noncompensated electron beams, critical currents in compensated, unlimited beams, the effect of the longitudinal dimensions of the system on the critical currents in the electron beams, the interaction of relativistic electrons with the plasma, the stability of the beams in the plasma, and critical currents of relativistic electron beams in the plasma. It was concluded that when the electron beam current is lower than both the critical current of the compensated beam and the boundary current of the noncompensated beam, no instability is generated in the system at the neutralized stage. (TTT)

28249 QUIESCENT BEAM-PLASMA SYSTEM. Gunshor, R. L.; Mundy, J. L.; Rawson, W. P. (Rensselaer Polytechnic Inst., Troy, N. Y.). Plasma Phys.; 11: 783-7(Sep 1969).

The construction and operation of a relatively quiet, well-behaved system for the study of beam-plasma interactions are described. Although convective and nonconvective instabilities in beam-plasma systems have been studied for some time and for many reasons, including a configuration that has been under investigation for microwave amplification, many experimental situations are limited by the problems associated with the various schemes for beam generated plasmas. Among these problems are large amplitude instabilities, and rf ionization due to growing waves in plasmas with low ionization levels. The latter condition means that ω_p is not a constant, and results which are related to collective phenomena are difficult to interpret. (auth) (UK)

28250 MECHANISMS OF ELECTRON LOSS IN A HYDROGEN AFTERGLOW. Cronin, J. C.; Sexton, M. C. (University Coll., Cork, Ireland). Proc. Roy. Irish Acad., Sect. A; 69: 1-9(1970).

The electron density decline over the range 10^{11} to 10^{10} cm^{-3} during the afterglow of a hydrogen discharge was monitored with a 9-GHz microwave interferometer. In the pressure range 2 to 7 torr, electron-ion recombination was inferred with coefficients within the narrow range 1.2×10^{-7} to 3.2×10^{-7} cm^3 sec^{-1}. The presence of the complex ions H_3^+ and H_5^+ was also considered in this region. At lower pressures, especially in the range 0.04 to 0.4 torr, the possibility of electron attachment to neutral atomic hydrogen is discussed and an attachment frequency of 3.9×10^3 sec^{-1} assigned. The large diameter discharge tube (12.7 cm) ensured that the volume removal processes of recombination and attachment remained significant to considerably lower pressures than was previously possible without a confining magnetic field. (auth) (UK)

28251 X-RAY TEMPERATURES FROM LASER-INDUCED BREAKDOWN PLASMAS IN AIR. Daiber, J. W.; Thompson, H. M. (Cornell Aeronautical Lab., Buffalo). J. Appl. Phys.; 41: 2043-7(Apr 1970).

The soft x-ray flux from laser sparks in air at a pressure near 330 torr was measured with a three-channel absorption spectrometer. From these measurements, plasma temperatures were inferred. For laser peak-power levels from 300 to 600 MW and pulse durations from 10 to 25 nsec, the temperatures varied from 40 to 160 eV. Streak-camera records were taken of the axial plasma growth. For the shortest laser pulses, the plasma temperatures and luminous front velocities were in near agreement with the predictions of the radiatively supported detonation-wave model. As the laser pulse width increased so did the plasma velocity, but not the temperature. These higher-velocity streak records also showed several slower-moving luminous fronts behind the faster front. These slower fronts are believed to be detonation waves. Space- and time-resolved x-ray flux measurements were also made, from which the x rays were found to be associated with the highly luminous plasma and only occurred during laser heating of the plasma. (auth)

28252 EFFECT OF ELECTRODE CONFIGURATION ON NORMAL IONIZING SHOCK WAVES. Blackburn, T. R.; Brennan, M. H.; Fletcher, J. (Flinders Univ. of South Australia, Bedford Park). Plasma Phys.; 11: 655-61(Aug 1969).

The characteristics of normal ionizing shock waves in hydrogen were investigated in a cylindrical geometry for three electrode configurations—coaxial electrodes, short center and outer ring electrodes, and short center electrode with outer cylindrical electrode. It is found that, while the fraction of the total input current driving the front depends on the electrode configuration, the shock velocity at a given drive current is the same for all three configurations. The shock velocities are also found to be in agreement with the theoretical predictions of Taussig and Woods. (auth) (UK)

28253 ELECTRON–ION RECOMBINATION IN LASER-PRODUCED PLASMA. Mattioli, M.; Veron, D. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Plasma Phys.; 11: 684-6(Aug 1969).

The experiments reported are concerned with the recombination of the ions of the produced plasma. Three types of measurement are made: analysis of the emitted light, mass spectrometry, and charge collection. (auth) (UK)

28254 RECOMBINATION AND ION-CONVERSION PROCESSES OF ARGON IONS. Veatch, G. E.; Oskam, H. J. (Univ. of Minnesota, Minneapolis). Phys. Rev., A; 1: 1498-1504 (May 1970).

The properties of Ar^+ and Ar_2^+ were studied in helium–argon mixtures by means of the afterglow method. The time dependence of the number density of these ions was measured by mass-spectrometric techniques. The temporal behavior of the intensity of various spectral lines was also determined. The studies established the occurrence of the collisional recombination process $Ar^+ + 2e \rightarrow Ar + e + h\nu$, while they confirmed the importance of the dissociative recombination process $Ar_2^+ + e \rightarrow Ar + Ar + h\nu$. The collisional process appeared to populate all levels studied, while the dissociative process selectively populated the 2p and 3p energy levels. The only ion–molecule–association reaction observed for argon concentrations between 0.01 and 5% was $Ar^+ + Ar + He \rightarrow Ar_2^+ + He$. The rate constant was found to be 8.0×10^{-32} cm^6 sec^{-1}. The value of the mobility for Ar^+ in the helium–argon mixtures obeyed Blanc's Law. (auth)

28255 METHOD AND APPARATUS FOR ACCELERATING IONS OUT OF A HOT PLASMA REGION. Post, Richard F. (to U. S. Atomic Energy Commission). U. S. Patent 3,500,077. 10 Mar 1970. Filed 19 Dec 1967.

A method and apparatus are described in which neutral atomic or molecular particles are directed into a magnetic field used to confine a high temperature plasma. The particles are directed along a beam path in the magnetic field upon which the particles are ionized by interaction with plasma particles and are accelerated from the magnetic field by the ambipolar electrostatic field produced by plasma particles differing therein. Electrical energy may be produced by collection of the accelerated ionized particles by collector electrodes outside the plasma. (USAEC)

28256 EXPERIMENTAL VERIFICATION OF THE INFLUENCE OF THE HALL EFFECT ON THE PENETRATION OF A HIGH-FREQUENCY TRAVELLING MAGNETIC FIELD INTO A PLASMA IN THE "DELTA" DEVICE. Khodataev, K. V.; Shimchuk, V. P.; Shchelokov, V. A. (Radiotechnical Inst., Moscow). Nucl. Fusion; 10: 37-42(Mar 1970).

The results of measurements made in a 40-eV plasma contained by a 500-Oe hf magnetic field traveling along a plasma column are compared with computed values for the penetration of such a field into a homogeneous solid cylinder with conductivity σ and free-electron concentration n. Very satisfactory agreement with theory is observed. In particular, the predicted dependence of the relative strength of the field due to the drift current on the parameter $f \sim \sqrt{\sigma B_0}/n$ is confirmed. With increasing f the relative strength of this field reaches a maximum of 0.8 and then decreases, the skin layer remaining substantially less than the radius of the plasma column. To obtain satisfactory agreement with theory, it was sufficient in the conductivity calculations to take into account the cross section for Coulomb collisions and the total cross section for electron–atom collisions. It is shown, in addition, that for ionization coefficients higher than 5%, the magnetic-field and plasma pressures balance. (auth)

28257 BEHAVIOUR OF A CYLINDRICAL CAVITY RESONATOR PARTIALLY FILLED WITH A MAGNETIZED PLASMA. Moresco, Maurizio; Zilli, Enrico (Univ., Padua). Ric. Sci.; 39: 341-5(Apr-Jun 1969).

It was confirmed that $\Delta f^-/f$ goes to zero for values of ω_p/ω smaller than unity, in agreement with a corrected perturbation theory treatment. The experimental values agree with those calculated in the density interval $\omega_p^2/\omega^2 \cong 0.05 - 0.4$. The modified perturbation theory gives a good approximation for the values of Δf^- and Δf^+ with $\omega_p^2/\omega^2 \cong 0.05 - 0.4$ over the variation of the magnetic field performed in the experiment. When the density rises, the agreement no longer holds near the cyclotron resonance and at even higher density it is found only for large values of the magnetic field. In general, the validity conditions are not the same for the two frequencies but, as one might expect, they are more restrictive for the "minus mode." (auth)

28258 EVALUATION OF THERMOELECTRIC EFFECTS IN THE NEAR-ELECTRODE REGION OF GAS DISCHARGES. Konovalov, A. E. Zh. Prikl. Mekh. Tekh. Fiz.; No. 5, 138-40 (Sep-Oct 1969). (In Russian).

The method developed by P. R. Smay et al., was used to examine the effect of thermoelectric phenomena on the heat flux in a plasma, determining simultaneously also the potential drop in front of the electrodes. Passage of high-intensity currents through the plasma are accompanied by the formation of spots on the electrodes. The studies indicated that at "low" currents of 10^6 A/m^2 and $T_\infty = 20{,}000$°K, the electrode temperature affects only slightly the heat flux because there is great differences between the temperatures of the plasma and of the electrode. In case of "high" currents (10^7 A/m^2) the temperature distribution exhibits a maximum caused by the Joule heat release, due to the enthalpy transfer by the electrodes. Again, the tenfold increase of the current was found to affect only slightly the heat flux; only at the cathode is the direction of the flux changed. Emissivity effects in front of the electrode complicate the direct comparison of experimental and theoretical data. The potential jumps on the electrodes cause additional energy inflow; this supplementary effect may be different at the cathode and the anode. (TTT)

28259 ELECTRICAL CONDUCTIVITY AND COLLISION FREQUENCY OF IMPACT-IONIZED NITROGEN IN A MAGNETIC FIELD. Cottereau, Marie-Joseph; Guilly, Jacques; Valentin, Pierre (Rouen Univ., Mont-Saint-Aignan, France). Compt. Rend., Ser. B; 270: 729-32(16 Mar 1970). (In French).

The transverse electrical conductivity of impact-ionized nitrogen in a magnetic field was measured by a method previously described. The electron temperature was shown not to be perturbed by the electric and magnetic fields imposed by the method, and the variation of the collision frequency of the electrons with the impact velocity was studied. The results are compared with the different values calculated from the various cross sections of N_2 and N. (France)

28260 AMPLIFICATION OF MICROWAVE OSCILLATIONS IN AN ARC DISCHARGE WITH A HOT CATHODE. Levitskii, S. M.; Filonenko, E. G. (Kiev State Univ.). Ukr. Fiz. Zh.; 15: 269-73(Feb 1970). (In Russian).

Amplification of the microwave oscillations was studied in an arc discharge with a hot cathode. It was found that the real amplification was 20 to 25 dB. The frequency characteristic of the amplification consists of some discrete bands with a width of about 10 MHz in the range from 50 to 200 MHz. A linear dependence was observed between the output and input powers, but when the input power has a large value, nonlinear effects counted. On the basis of measuring dispersion characteristics of the plasma waves, it is concluded that generation and amplification are stimulated by a synchronous interaction of the plasma waves with the electron stream accelerated in the range of the potential cathode drop. (auth)

28261 PLASMA BEHAVIOR IN A TOROIDAL HIGH-β DEVICE. Gallagher, Charles C.; Combes, Lewis S.; Levine, Morton A. (Air Force Cambridge Research Labs., Bedford, Mass.). Phys. Fluids; 13: 1617-25(Jun 1970).

The stability of a cusp magnetic field was combined with the low loss rate of a closed-field configuration in a series of three small toroidal devices designed for plasma containment. In operation, a pinch, partly stabilized by an axial magnetic field, is produced prior to application of the containing cusp field. The axial stabilizing field of the pinch is then trapped by the plasma so that closed field lines are maintained within the plasma while the cusp is excluded from the plasma. There is no evidence of turbulence and the device exhibits a loss rate an order of magnitude below that to be expected from the same device operated as a minimum-B configuration without field trapping. Containment time is dependent on the decay rate of the applied cusp field. Maximum value of β within the plasma exceeds 2 and β remains above 1 for 15 μsec. Electron densities and temperatures exceed 10^{16} cm^{-3} and 10^{5}°K, respectively. (auth)

28262 BEAM INSTABILITY OF A CURRENT, AND PLASMA HEATING BY AN ELECTRON BEAM PRODUCED IN A LINEAR DISCHARGE. Karchevskii, A. I.; Averin, V. G.; Bezmel'nitsyn, V. N. Zh. Eksp. Theor. Fiz.; 58: 1131-45(Apr 1970). (In Russian).

It is demonstrated experimentally that in a linear strong-current discharge (current $I \approx 15$ kA, frequency 640 kHz) with a plasma density between 1×10^{13} and 7×10^{13} cm^{-3} in strong electric fields ($E \lesssim 500$ V/cm) a beam current instability develops, the current is carried by a small fraction ($\sim 10^{-3}$) of the plasma electrons, and the main part of the discharge current is carried by the beam of accelerated electrons. The electron beam may be passed through the anode of the system and is of interest from the viewpoint of carrying out, for example, physical investigations of plasma heating in the plasma–beam system. The parameters of the electron beam passing through the anode are the following: total beam current 10 to 15 kA, beam electron density $n' \approx 10^{11}$ cm^{-3}, energy of electrons in the beam ϵ' varies between 3 and 20 keV, duration of beam ~0.6 μsec, electron beam power ~100 MW, beam electron current density ~70 A/cm^2. Interaction between the electron beam and a cold plasma with a density between 1×10^{13} and 7×10^{13} cm^{-3} leads to strong beam heating of the plasma to a pressure $nT \approx 10^{16}$ eV/cm^3 and a hot plasma confining time in a mirror trap device of the order of 20 μsec. It is shown that the "anomalous" ohmic resistance of the linear discharge (which in these experiments is the electron gun) can be observed during the first half-period of the current and is due to restriction of the number of carriers in the turbulent zone of the discharge, electron acceleration, and transfer of energy by accelerated electrons to the system anode. (auth)

28263 SHOCK AND CURRENT SHEET STRUCTURE IN A THETA-PINCH CONFIGURATION. Alidieres, M.; Aymar, R.; Koechlin, F.; Jourdan, P.; Samain, A. (EURATOM–CEA, Fontenay-aux-Roses, France). Phys. Fluids; 13: 1525-32 (Jun 1970).

The structure of a current sheet during the compression of an argon plasma with no bias field is studied in a theta-pinch configuration. The profiles of magnetic field, particle density, mean velocity, and temperature are measured. No perturbation in front of the sheet is observed. It is shown that the initial gas passes through the sheet, emerging downstream, with a small relative velocity. During this acceleration process, the ion and electron temperatures remain small. The initial energy of ions relative to the sheet is thoroughly converted into thermal electron energy and in turn is radiated away through excitation of argon ions. The plasma motion, as well as the structure of the sheet, can be explained using fluid equations and Ohm's law. These equations are similar to those that govern the structure of a transverse shock wave with the resistivity as the only dissipative process. (auth)

28264 ANOMALOUS DECAY OF A NONUNIFORM COLLISIONLESS PLASMA BEAM IN A UHF FIELD. Sergeichev, K. F. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Theor. Fiz.; 58: 1157-67(Apr 1970). (In Russian).

Anomalous decay of a nonuniform collisionless plasma beam injected into a circular waveguide and excited by an H_{01} mode wave in the S band is investigated. Anomalous decay is found to be a threshold effect with respect to the electric field strength of the applied uhf field. The dependence of the decay threshold on plasma density is found. The threshold dependence is compared with theoretical dependence of the kinetic and parametric instability thresholds of a nonisothermal plasma in a uhf field; these instabilities could be the cause of heating and decay of the plasma. Qualitative relations of the dependences for a rarefied plasma ($n/n_0 < 0.8$) are demonstrated. The remaining discrepancy can be explained by the influence of the plasma inhomogeneity on the decay threshold magnitude. This is confirmed by the fact that better agreement with theory was obtained for the decay thresholds of a weakly inhomogeneous plasma beam in a uhf field. Anomalous decay of a dense plasma ($n_{max}/n_0 > 1$) was investigated by means of a surface wave excited on violation of symmetry of injection of the plasma beam into the field of the H_{01} wave. It is shown that a dense plasma practically does not participate in the anomalous decay process and that, in this case, decay occurs in the nonuniform boundary plasma layer in which $n/n_0 \lesssim 1$. (auth)

28265 STUDY OF HEAT FLUXES IN A PULSED PLASMA ACCELERATOR. Rusanov, V. P.; Safronov, B. G.; Vereshchagin, V. L.; Popov, N. P. Inzh.-Fiz. Zh.; 18: 534-7(Mar 1970). (In Russian).

During the pulsed operation of an erosion-type plasma accelerator, the thermal state of structure elements is determined and the parameters of the plasma jet are measured. The inner electrode is shown to have the highest temperature. Within the operation of the accelerator, an intensive rise in dielectric temperature takes place resulting in changes in the plasma-jet parameters. Estimation of the energy distribution in a discharge was carried out from the measurement results. (auth)

28266 EXPERIMENTAL TOTAL AND TOTAL LINE RADIATION OF NITROGEN, OXYGEN, AND ARGON PLASMAS. Krey, R. U.; Morris, J. C. (Avco Corp., Wilmington, Mass.). Phys. Fluids; 13: 1483-7(Jun 1970).

Total radiation measurements for nitrogen, oxygen, and argon plasmas are presented for 2,000 Å $< \lambda <$ 60,000 Å and for temperatures from 9,000 to 15,000°K. These data are compared to previous measurements for the total continuum and to theoretical calculations for the total line radiation. The line radiation was found to be of the same order of magnitude as the total continuum. Taking into account the effect of absorption in the total radiation measurements, a lower limit is obtained for the accuracy of theoretical total line radiation calculations. (auth)

28267 INVESTIGATION OF THE HIGH FREQUENCY INSTABILITY THRESHOLD IN THE INTERACTION BETWEEN AN ELECTRON BEAM AND PLASMA. Bogdankevich, L. S.; Raizer, M. D.; Rukhadze, A. A.; Strelkov, P. S. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Theor. Fiz.; 58: 1219-33(Apr 1970). (In Russian).

The critical plasma density for which high-frequency instability arises in the plasma–beam system is determined experimentally. The dependence of the critical density on the electron beam density, magnitude of the external magnetic field and geometric dimensions of the system are investigated. The threshold conditions for excitation of electrostatic oscillations, derived from an analysis of the dispersion equation for a restricted plasma–beam system, agree with the experimental data. A comparison between the theory and experiment shows that, in the given experimental conditions, the critical values of the plasma density correspond to excitation of axially symmetric oscillation modes. (auth)

28268 LASER ACTION AND PLASMA PROPERTIES OF AN ARGON Z-PINCH DISCHARGE. Illingworth, R. (Univ. of Strathclyde, Glasgow). J. Phys., D (London); 3: 924-30(Jun 1970).

An experimental investigation of visible and ultraviolet laser action in a small argon z-pinch plasma has been made. The effect of initial gas pressure on the peak laser output power, implosion time, time of ultraviolet laser action, and axial electron density is described, and streak photographs of the discharge are presented. Laser action at 4765 Å due to Ar^+ is observed in the initial stages of the discharge at pressures below 7 mtorr. Laser action at 3511 Å due to Ar^{2+} occurs as a short pulse at higher initial gas pressures just after the imploding current sheath reaches the axis of the discharge tube. Typically, the axial electron density at the time of peak ultraviolet laser action was found to be 1.0×10^{15} electrons cm^{-3}, although at certain gas pressures slightly larger values were found. Large electron density gradients occur just after ultraviolet laser action. (auth) (UK)

28269 HIGH-PRESSURE PLASMAS WITH INCREASED DENSITY OF ENERGY AND RADIATION. Roeder, G. (Technische Hochschule, Darmstadt, Ger.). Z. Angew. Phys.; 29: 41-9(23 Apr 1970). (In German).

For the ignition of gaseous discharges at discharge voltages below the ignition potential, a thin, preheated tungsten wire is used that gives a preionization in the gap between the electrodes and does not explode at ignition. This ignition wire has, on the Paschen curve, almost no influence on the radiation and the development of the plasma channel. As a result of the preionization, turbulence in the plasma at high pressures is prevented and the radiation-density is increased. The axis of the channel is determined by the ignition wire. The plasma resistance can be increased so far that the damping of the discharge becomes aperiodic. At this optimal condition of discharge, the physical properties of the plasma can be calculated. The timely expansion of the

plasma channel can be formulated into a principle. The channel radius has at an exact moment, before the maximum current, and independent of the initial conditions, always the same value. An increase of the initial pressure at a constant discharge voltage leads to a decrease in plasma volume and to improvement of the electric adaptance, whereby the energy density in the plasma in relation to the values on the Paschen curve can be increased by a factor of 100. The radiation density increases only in a smaller quantity due to the optical opaqueness. It can, in relation to the upper limit of the known radiation-saturation on the Paschen curve, almost be doubled. (auth)

28270 THERMALIZATION AND TIME-DEPENDENT DEVELOPMENT OF THE ELECTRON DENSITY AND TEMPERATURE OF DISCHARGE CHANNELS IN HYDROGEN. Tholl, H. (Univ., Hamburg). Z. Naturforsch.; 25a: 420-9(Mar 1970). (In German).

In a streamer-initiated predischarge channel in H_2, the axial and radial electron density distributions were measured at different times of the channel development. It was found that at any point in the channel where the electron density reaches $\approx 2 \times 10^{17}$ cm^{-3}, an immediate thermalization of the plasma at this point takes place in a time of ≈10 nsec. Due to the inhomogeneous radial and axial electron density distribution in a streamer-initiated discharge channel, the thermalization begins at first in a constricted region of the channel. The further development of the electron density and temperature distributions in the thermalized channel was studied by means of spectroscopic plasma diagnostic methods in channels initiated by different overvoltages. These experiments have shown that the inhomogeneous axial electron density distribution is equalized after a time of ≈100 nsec. The maximum electron density of ≈1 to 2×10^{18} cm^{-3} is reached in the channel axis immediately after the thermalization of the channel whereas the temperature increases during the time of the highest energy input to the maximum of ≈5 to 6×10^4 °K. (auth)

28271 MEASUREMENT OF THE TEMPERATURE AND PARTIAL PRESSURE OF A URANIUM PLASMA. Schneider, R. T.; Randol III, A. G.; Shipman, G. R. (Univ. of Florida, Gainesville). Appl. Spectrosc.; 24: 253-8(Mar-Apr 1970).

The generation of a high-pressure uranium plasma is described. Determinations of temperature, uranium-II, and electron pressure are performed. The Boltzmann plot technique and the single-line, relative-intensity method are used. Radial distributions of the measured quantities across the plasma are given. Plasma temperature as a function of power input and pressure is measured. These temperatures range between 7900 and 10,300°K. Uranium partial pressures between 0.1 and 1.0 atm are deduced. (auth)

Kinetics (Theoretical)

28272 (AD-700107) INTRODUCTION TO PLASMA VORTICES. Norwood, Joseph Jr.; Wells, Daniel R. (Miami Univ., Coral Gables, Fla. Plasma Physics Lab.). Oct 1969. 42p. (MIAPH-PL-69,15; AFOSR-70-94-TR). CFSTI.

A property of plasmas that has far-reaching consequences for plasmas as created in the laboratory and for astrophysical plasmas is investigated. The property is this: if a plasma exists in the presence of a magnetic field, forces will arise due to small space and/or time variations in the magnetic field and/or velocity field which will lead to vortical motion of the plasma. A tendency to form vortices in reaction to external perturbation is a universal property of fluids. In addition to the hydrodynamic forces, the plasma is also subject to an electromagnetic force. The hydrodynamic forces are the centripetal force, proportional to the square of the velocity divided by the local radius of curvature of the streamline and the Magnus force, proportional to the product of the vorticity and the component of velocity perpendicular to it. The electromagnetic force (known as the Lorentz force) is proportional to the product of the current and the component of magnetic field strength perpendicular to it. The electromagnetic Lorentz force and the fluid dynamical Magnus force have opposite signs. It is precisely upon this sign difference that the richness of plasma vortex behavior rests. (auth) (USGRDR)

28273 (IPPJ-88) MAGNETIC SURFACES AND DRIFT SURFACES OF AVERAGE MIN. B STELLARATOR FIELD. Miyamoto, Kenro (Nagoya Univ. (Japan). Inst. of Plasma Physics). Mar 1970. 32p. Dep. CFSTI (U. S. Sales Only).

Magnetic surfaces and drift surfaces of a single charged particle of an average minimum-B stellarator field are analyzed by using an average method. Dependencies of the well depth, rotational transform angle, and shear on the geometrical parameters and current magnitudes of the current configurations and the possible ranges of the value of quantities of the magnetic field are studied, and these results are compared with computed ones. The deviation of the drift surfaces of untrapped particles from the magnetic surfaces is studied, and it is found that the deviation is approximately equal to the deformation of the magnetic surface due to the application of an equivalent vertical field. A condition of ion Larmor radius and the rotational transform angle are obtained for the small deviation of the drift surface from the magnetic one. The effects of geometrical errors of the current configurations on the magnetic surface are analyzed numerically, and a tolerable amount of the error is deduced. (auth)

28274 (N-70-11902) EFFECT OF FINITE LARMOR RADIUS ON THE PERTURBATION FLOW MIXING OF A COLLISIONLESS PLASMA. Morioka, Shigeki; Spreiter, John R. (Stanford Univ., Calif. Dept. of Applied Mechanics). [1968]. 34p. (NASA-CR-106965). CFSTI.

The Chew–Goldburger–Low theory of a collisionless plasma, modified to include the effect of finite Larmor radius of the ion and the electron, is applied to a linearized problem of two-dimensional steady flow. The zeroth-order terms in the Larmor radius expansions of the velocity distribution functions of the ion and the electron are assumed to be anisotropic Maxwellian. The spatial development of a given velocity profile is investigated for flows with either crossed or aligned and magnetic fields, and for various values of Mach number, Alfven Mach number, and anisotropic pressure ratios in the main flow. (auth) (STAR)

28275 (ORNL-TM-2988) ANOMALOUS RESISTIVITY IN TOKAMAK TM-3. Hirose, A.; Murakami, M.; Alexeff, I. (Oak Ridge National Lab., Tenn.). May 1970 Contract W-7405-eng-26. 5p. Dep. CFSTI.

The anomalously low electrical conductivity observed in the Tokamak TM-3 device is interpreted in terms of an ion–acoustic instability. (auth)

28276 ROTATION OF A COLLISIONAL THETA-PINCH PLASMA. Benford, G. (Univ. of California, Livermore). Plasma Phys.; 11: 787-9(Sep 1969).

Theta-pinch plasmas have been observed to rotate rapidly, lose rotational symmetry and become turbulent. Recently, Düchs (1968) investigated rotation using a two-dimensional computer model for a collisional plasma. He finds appreciable rotation if a transverse magnetic field exists across the plasma. In recent experiments on collisional plasma (Benford, 1969) rotation was found. This raises the question of whether a previous mechanism due to Velikhov (1964) for collisionless plasmas may be present here as well. Following Velikhov, a plane layer of plasma uniform along the y-axis and moving along the x-axis, parallel to the imposed magnetic field B is considered here. (auth) (UK)

28277 INTERACTION OF INHOMOGENEOUS BEAM WITH SURFACE WAVES IN MAGNETOACTIVE PLASMA. El-Siragy, N. M.; Pakhomov, V. I. (Atomic Energy Establishment, Cario) Plasma Phys.; 11: 707-14(Sep 1969).

The excitation of potential surface oscillations on the plane boundary of the magnetoactive plasma by an inhomogeneous hot beam of charged particles is investigated. Expressions for the growth rates are obtained. (auth) (UK)

28278 DIFFUSION IN DECAYING PLASMAS. Kregel, Mark D. (Army Aberdeen Research and Development Center, Aberdeen Proving Grounds, Md.). J. Appl. Phys.; 41: 1978-83(Apr 1970).

An iterative numerical technique was employed to model the decay of plasmas in an electronegative gas, nitric oxide, and in an electropositive gas, helium. The spatial and temporal behavior of the charged species are followed and compared with experiments through four regimes: (1) positive ion–electron ambipolar diffusion regime, (2) transition regime, (3) positive ion–negative ion ambipolar diffusion regime for an electronegative gas, and (4) free diffusion regime for an electropositive gas. Densities of all charged-particle species are calculated from Gauss' law. The structural features in the experimental measurements of decaying plasmas are reproduced in the results of the numerical calculation. (auth)

28279 UNIFIED TRANSPORT THEORY OF PARTIALLY IONIZED NONISOTHERMAL PLASMAS. Daybelge, Umur (Teknik Univ., Istanbul). J. Appl. Phys.; 41: 2130-9(Apr 1970).

The unified charged-particle interaction operators of Kihara and Aono are used in the system of kinetic equations for a partially ionized, nonisothermal gas in a magnetic field. It is assumed that the coupling between the kinetic equation of the electrons and those of the heavy species is weak, as it is always the case in MHD-generator plasmas. It is demonstrated that the new theory introduces essential corrections to the values of transport coefficients calculated by other theories of nonisothermal plasmas.

Simplified calculation methods for electron transport coefficients are proposed, based on the exact results given by this theory. (auth)

28280 COLLISIONAL DAMPING OF THE HIGH-FREQUENCY INSTABILITY IN A BEAM–PLASMA SYSTEM. Boehmer, H.; Chang, J.; Raether, M. (Univ. of Illinois, Urbana). Plasma Phys.; 11: 645-54(Aug 1969).

The high-frequency instability resulting from the interaction of a cold electron beam with a cold plasma is investigated in the collisionless as well as collision-dominated regime. Measurements of the beam distribution function show that the instability is heavily damped at high plasma densities and exhibits a maximum at intermediate densities. The results are in good agreement with theoretical calculations invoking Coulomb collision as the main damping mechanism. Heating of the plasma by the instability can cause a drastic shift of the density of maximum instability to higher values. (auth (UK)

28281 SLOWING DOWN OF A FAST TEST PARTICLE IN A PLASMA. Husseiny, A. A.; Forsen, H. K. (Univ. of Wisconsin, Madison). Phys. Rev., A; 1: 1483-7(May 1970).

The elastic scattering of fast charged particles in a background plasma is considered. Investigation is limited to scattering by Maxwellian particles whose most probable speed is much less than the velocity of the fast test particle. A shielded-potential elastic-scattering cross section is used to formulate the scattering kernel. By taking the moments of the kernel, it is possible to obtain expressions for the rate of energy transfer, the slowing-down time, the rate of the mean-square energy transfer, and the dispersion of the initial energy distribution of the fast particles released to the background. (auth)

28282 INFLUENCE OF SURFACE EMISSIVITY ON CONDUCTION, CONVECTION, AND RADIATION IN A NONISOTHERMAL HYDROGEN PLASMA. Mandell, D. A. (Washington State Univ., Pullman). J. Quant. Spectrosc. Radiative Transfer; 10: 459-63 (May 1970).

The influence of the surface emissivity on combined conduction, convection, and radiation heat transfer in a nonisothermal hydrogen plasma was studied. The problem of fully developed laminar flow and heat transfer between gray parallel boundaries with a constant wall heat flux was considered. The assumptions of linearized radiation and local thermodynamic equilibrium were made. The results are presented in terms of a dimensionless bulk temperature. Both the optically thin and optically thick solutions were independent of the surface emissivity. This was in contrast to work done within infrared radiation where the optically thick solution depended upon the surface emissivity. The results show that the surface emissivity did not have a large influence on the dimensionless bulk temperature. (auth) (UK)

28283 THEORETICAL MODEL FOR A NONEQUILIBRIUM HELIUM ARC PLASMA. Tsussig, R. T. (Columbia Univ., New York). J. Quant. Spectrosc. Radiative Transfer; 10: 449-58 (May 1970).

A semi-empirical model for a nonequilibrium helium arc plasma was used to interpret systematic deviations in existing spectroscopic data and to aid in computing nonequilibrium plasma transport properties. Two groups of bound electronic states assumed to exist which follow Boltzmann distributions at T_e (upper states) and $T_R \neq T_e$ (lower states). Under certain conditions, T could have been interpreted as a radiation temperature characterizing the optically thick part of the spectrum and could have been calculated using a restricted Rosseland approximation. The nonequilibrium plasma was characterized by electron densities as much as several orders of magnitude greater than the local thermodynamic equilibrium value. The model reproduced the experimental data in detail once the electron temperature profile was given. (auth) (UK)

28284 HYDRODYNAMICS OF COLLISIONAL PLASMA IN A STRONG INHOMOGENEOUS MAGNETIC FIELD. Nemov, V. V. (Inst. of Technical Physics, Kharkov). Nucl. Fusion; 10: 19-28(Mar 1970).

On the basis of Boltzmann's kinetic equations, hydrodynamic equations were obtained for the ions and electrons of a fully ionized collisional plasma in a strong inhomogeneous magnetic field under assumptions characteristic of works on "drift" instability. These equations are a generalization of the results of Mikhailovsk's work on an inhomogeneous magnetic field and make it possible to solve problems connected with the hydrodynamic drift instability of plasma in the presence of shear, curvature of the lines of force and inhomogeneity of the absolute value of the magnetic field. (auth)

28285 AN ANALOG DEVICE FOR SOLVING THE VLASOV DISPERSION EQUATION. Stainov, G. Z. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 22: 1369-71(1969).

The dispersion equation is presented in the following dimensionless aspect: $-k^2 = \Sigma_i a_i W_i(z) = \Sigma_i a_i \int_{-\infty}^{+\infty} (f_i (p_i u_i) du/z - u)$ wherein $W_i(z) = U_i(xy) + jV_i(xy)$ are analytical functions of the complex variable $z = x + jy = (\omega/ks_e)$. The index $i = 0, 1, 2 \ldots$ is used to designate the separate components of the plasma. Real and imaginary solutions are obtained. (M.O.W.)

28286 PARTICLE CORRELATIONS IN A CLASSICAL ONE-COMPONENT PLASMA. Berggren, K.-F. (FOA, Stockholm). Phys. Rev., A; 1: 1783-91(Jun 1970).

The effect of particle correlations in a classical system of charged particles moving in a static uniform background is investigated by means of a dielectric theory developed by Singwi et al., for a completely degenerate electron gas. In this theory, the short-range correlations arising from the Coulomb interaction are taken into account through a local-field correction depending on the pair correlation function. In a first approximation (I), the pair correlation function is chosen to be time independent. The extension of allowing also the pair correlation function to adjust itself to the external field results in a screening of the Coulomb potential entering the local field. The effect of this screening has been investigated for the cases of a static random-phase approximation (RPA) dielectric function (II) and a static fully self-consistent dielectric function (III). Numerical self-consistent calculations have been carried out for the cases I-III in order to determine the static structure factor $S(\vec{q})$. From $S(\vec{q})$ thus obtained, the Helmholtz free energy, the correlation energy, the pair correlation functions, and the isothermal compressibility have been calculated numerically. The plasma dispersion and the compressibility sum rule have also been investigated. The present method can be regarded as a rather natural extension of the RPA. Considerable improvement upon the simple Debye–Hückel (or, equivalently, classical RPA) is also found. The results of the present calculations are also compared with the results of other elaborate methods. (auth)

28287 NEW STATISTICAL DESCRIPTION OF A PLASMA IN THERMODYNAMIC EQUILIBRIUM IN THE DEBYE APPROXIMATION. Clavin, Paul; Wallenborn, Jean (Brussels Univ.). Compt. Rend., Ser. B; 270: 717-20(16 Mar 1970). (In French).

The transformation method developed by Prigorine et al. in Brussels is used for evaluating the transformed distribution function reduced to a particle $\tilde{\varphi}(v)$, in classical plasmas in equilibrium in the Debye approximation. This new function describes the distribution according to the velocities, of "physical particles" which, in their definition include the correlations. It serves as a substitute for the Maxwell distribution law. The Debye entropy of the system is the same as for a perfect gas: $S = -k \int \tilde{\varphi}(v)$ Log $\tilde{\varphi}(v)$ dv. (France)

28288 DEPENDENCE OF PRESSURE ON THE MAGNETIC FIELD IN AN ARC SURROUNDED BY COLD GAS. Rem, J. (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Nucl. Fusion; 10: 95-7(Mar 1970).

A relationship is derived for the dependence of an applied axial magnetic field on the operating pressure of an arc. The arc was surrounded by a cold gas. (M.O.W.)

28289 EFFECT OF KINETIC ENERGY CORRECTIONS ON DEGREE OF IONIZATION. Wright, T. P.; (Sandia Labs., Albuquerque, N. Mex.); Theimer, O. H. Phys. Fluids; 13: 1641-2 (Jun 1970).

A Saha equation is derived for a system exhibiting a classical kinetic energy correction. The resulting form of the degree of ionization has a correction term that may be experimentally observable. (auth)

28290 RELAXATION PROCESSES IN ELECTRODYNAMIC PLASMA ACCELERATION. Kolesnikov, P. M.; Stolovich, N. N. (Minsk Inst. of Heat and Mass Exchange). Inzh.-Fiz. Zh.; 18: 517-26(Mar 1970). (In Russian).

The relaxation processes are considered, and the corresponding mass transfer equations that account for the processes of Joulean erosion of electrodes, diffusion of particles, recharging, and time delay of mass generation are solved. (auth)

28291 INTERACTION OF AN IONIZING SHOCK WAVE WITH A TRANSVERSE MAGNETIC FIELD. Bout, Dmitri A.; Gross, Robert A. (Columbia Univ., New York). Phys. Fluids; 13: 1473-9(Jun 1970).

A strong ionizing shock wave penetrating a transverse magnetic field is analyzed. The distribution of magnetic field behind the shock front is obtained. It is shown that for a steady-state magnetic field ahead of the shock front, at high magnetic Reynolds numbers, the field is swept along as a contact discontinuity initiated at the moment the shock enters into the field. For a magnetic field ahead of the shock front increasing rapidly in time,

the field behind the shock front decreases sharply with the distance. The interaction of the incident shock with the magnetic field results in forming a reflected shock and a transmitted shock whose speed is less than that of the incident shock. The value of the magnetic field is found for which reflection of the incident shock is similar to the reflection from a solid wall. (auth)

28292 EFFECT OF INELASTIC COLLISIONS ON ELECTRON TRANSPORT COEFFICIENTS. Fox, R. L. (Sandia Labs., Albuquerque, N. Mex.). Phys. Fluids; 13: 1480-2(Jun 1970).

A method is described for determining the maximum contribution of inelastic collisions to the transport properties of electrons in neutral and partially ionized gases. The inelastic collision cross sections are obtained from asymptotic expressions. The calculation was carried out for electron diffusion in neutral argon and lithium vapor and for the electrical conductivity or argon. The inelastic contribution to the diffusion coefficient displays a similar behavior for both the gases considered. The effect of inelastic collisions on the electrical conductivity was found to be less than 1% over the temperature range from 5,000 to 25,000°K. (auth)

28293 THEORY OF THE POSITIVE COLUMN INCLUDING ELECTRON-ION RECOMBINATION. Lindgren, R. G.; Gavalas, G. R. (California Inst. of Tech., Pasadena). Phys. Fluids; 13: 1499-1503(Jun 1970).

A theoretical study of the effect of electron–ion recombination on the voltage–current characteristic of the positive column of a glow discharge is presented. In the absence of recombination, as the current increases the voltage decreases and reaches a constant value. In the presence of recombination, and at sufficiently high currents, the voltage increases with increasing current. (auth)

28294 VELOCITY DIFFUSION IN RESONANTLY PERTURBED MAGNETIC FIELD. Clarke, J. F.; Lidsky, L. M. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids; 13: 1580-5(Jun 1970).

Charged-particle motion in perturbed magnetic fields can often be described as a random walk on a constant energy surface in velocity space. The particle–field interaction is strongest in "resonant perturbations" —those for which the characteristic wavenumber of the field perturbation is related to $v_{||}$, the velocity of the particle along the direction of the average magnetic field, by $kv_{||} = \omega$, where ω is the cyclotron frequency in the average field. Such fields occur (for example) as the magnetic component of slow transverse plasma waves. The random walk is usually described by a Fokker–Planck equation whose coefficients depend on the square of the perturbation field strength. Under certain conditions, this description is incorrect. If the field amplitude is strong enough to affect the phase correlation between the field and the particle before this correlation is destroyed by fluctuations in the field, the Fokker–Planck coefficients take on half-integral power dependences on the perturbation field strength. This behavior depends only on the relative magnitudes of the correlation times and occurs in an exactly analogous fashion for electrostatic perturbations. A criterion for determining the importance of this effect in particular cases is developed and compared with the results of a computer experiment. (auth)

28295 INTENSE RELATIVISTIC ELECTRON BEAM IN A PLASMA. Ivanov, A. A.; Rudakov, L. I. Zh. Eksp. Teor. Fiz.; 58: 1332-41(Apr 1970). (In Russian).

The equilibrium and stability of an intense relativistic electron beam injected into a plasma is considered. In a dense plasma the beam produces a back current that compensates its field. Ohmic dissipation of the back current leads to the appearance of a magnetic field that focuses the beam. The focal length and minimal beam radius are determined. Possible equilibrium states are discussed. Instability of the beam with respect to large-scale snake-like perturbations that are dangerous for focusing (hose instability) and also beam instability with respect to local pinching are discussed. (auth)

28296 PROPAGATION OF SHOCK WAVES IN A MEDIUM OF DECREASING DENSITY. Gurevich, L. E.; Rumyantsev, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 58: 1395-9(Apr 1970). (In Russian).

The front of a shock wave propagating in a medium of decreasing density is unstable with respect to perturbations, the wavelengths of which are much smaller than the inhomogeneity length and, in particular, smaller than the height of a nonuniform atmosphere. As a result, the wave front separates into small regions, the dimensions of which are slightly smaller than the inhomogeneity length. These small regions move in various directions, collide, and produce a diffusion pattern of the spreading wave front. In the case of a star, the time of instability development is much smaller than the time for "diffusion" of the front to the surface. It is pointed out that an explosion of such duration may occur that the trailing edge of the shock disturbance cannot overtake the leading edge before the latter leaves the system and there will not be enough time for the Riemann shock wave to be produced. (auth)

28297 KINETIC THEORY OF SUBSONIC AND SUPERSONIC TRANSPORT PROCESSES FOR SCREENED COULOMB INTERACTIONS. Wilhelm, H. E. (Colorado State Univ., Fort Collins). Z. Naturforsch.; 25a: 322-8(Mar 1970).

A statistical theory of the intercomponent transport processes is given for nonisothermal plasmas consisting of electron and ion components, when the particles interact through Coulomb collisions screened electrostatically beyond the Debye radius. The associated collision integrals are evaluated analytically for arbitrary drift velocities of the components, and under consideration of the velocity dependence of the Coulomb logarithm. The resultant analytical relations form consistent mathematical foundations for a transport theory of systems with collisional Coulomb interactions. It is shown that different properties of the transport processes and the effective Coulomb logarithms result for subsonic and supersonic drift velocities of the components. (auth)

28298 PLASMA BOUNDARY AS A MACH SURFACE. Stangeby, P. C.; Allen, J. E. (Oxford Univ.). J. Phys., A (London); 3: 304-8(May 1970).

Ion motion in a plasma is treated by the equations of compressible fluid flow. The plasma–sheath boundary is identified as a closed Mach surface thus demonstrating that the Bohm (1969) criterion applies to the component of ion velocity normal to the sheath edge. (auth) (UK)

28299 DETERMINATION OF THE RADIAL TEMPERATURE DISTRIBUTION IN PLASMA COLUMNS WITH SELF-ABSORPTION. Meiners, D.; Weiss, C. O. (Technische Univ., Hanover). Z. Angew. Phys.; 29: 35-40(23 Apr 1970). (In German).

The radial temperature distribution in a stationary high-pressure mercury arc (maximum temperature 7500°K) was measured by use of two different methods in order to get information about their accuracy. On the one hand, the temperature distribution was determined applying the method of Bartels, which is based on measuring the maximum intensity of a self-reversed spectral line. On the other hand, the radial distributions of the emission coefficient and of the absorption coefficient were calculated from measurements of the lateral distributions of intensity and optical thickness. By application of Kirchhoff's law the radial temperature distribution is determined. The results obtained by the two methods are in good agreement. In the center of the arc the temperature differences are less than 1%. (auth)

Production

28300 A THERMIONIC LITHIUM PLASMA SOURCE FOR DRIFT-WAVE EXPERIMENTS. Burt, J.; Little, P. F.; Stott, P. E. (Culham Lab., Abingdon, Eng.). Plasma Phys.; 11: 789-93(Sep 1969).

An experiment to investigate drift waves in a cylindrical column of plasma produced by the thermal ionization of lithium atoms at a hot metal surface is described. Considerations of power consumption in the field windings limited the column radius R and therefore a lithium plasma was used in order to make the ion Larmor radius a_i small. In this way the ion-cyclotron instability was avoided. (auth) (UK)

28301 GENERALIZATION OF THE OPERATIONAL CHARACTERISTICS OF A SECTIONAL PLASMATRON WITH COMPRESSED CHANNELS. Kosarenkov, V. A.; Ryabtsev, E. I.; Stel'makh, G. P.; Chesnokov, N. A. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 115-18 (Jan-Feb 1970). (In Russian).

The volt–ampere characteristics of a sectioned-channel plasmatron were determined at reduced pressures. The velocity of the jet may be increased by increasing the gas consumption, reducing the pressure, and improving the nozzle design. The jet-diaphragm plasmatron studied consisted of 6 sections with 20-mm diameter and 20-mm high channels. The 4, 8, 12 or 16-mm nozzle was attached at the anode section; the argon consumption was varied from 0.2 to 3.5 g/sec. The experimental pressure ranged from 1.33×10^2 to 1.33×10^3 n/m^2; upon compression in the channels, it varied from 1.33×10^3 to 1.33×10^5 n/m^2. The enthalpy of the jet was calculated from the thermal balance of the system. The data obtained were compared with generalized criterial relations. The following correlation was obtained: $U = 1.91\ I^{-0.2}\ K^{-1.9}\ D^{-1.3}$, when $10^2 < I < 10^3$, $5 \times 10^3 < K < 5 \times 10^3$, and $1 < D < 5$, whereby U was derived from Ohm's law, I from the energy equation and D

represents the ratio of the diameters of the channel and the nozzle. Under certain conditions the relationship becomes $U = 0.6\ I^{-0.2}\ K^{-1.0}\ D^{-1.3}\ L^{0.63}$, when $0.3 < L\ 11.0$, whereby L is a geometric factor. The formula allows estimation of the operational characteristics of plasmatrons. (TTT)

28302 HYDROGEN PLASMA PRODUCTION BY GIANT PULSE LASERS. Mulser, Peter (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch.; 25a: 282-95(Feb 1970).

The problem of interaction of an intense laser beam with solid hydrogen is theoretically investigated in a one-dimensional plane geometry. The time-dependent distributions of density, temperature, and velocity of the produced plasma as well as those of the solid are found by numerical solution of the hydrodynamic equations for various laser powers. The maximum temperature can be approximately expressed in closed form as a function of the laser intensity and time. The calculations allow for the influence of thermal conduction and viscosity. At laser intensities above 1.8×10^{11} W/cm^2 the plasma frequency rises above that of the laser in the transition sheath between the hot plasma and the cold solid. The problem of absorption and reflection of laser radiation in this region is investigated. (auth)

28303 CONTACT SURFACE AND SHOCK WAVE IN AN ELECTROMAGNETIC SHOCK TUBE. Bensimon, Jacques (Univ., Paris); Laurent, Joel; Lesigne, Bernard; Lasek, Andre. Compt. Rend., Ser. A; 270: 790-3(23 Mar 1970). (In French).

The distance that separates the front of the shock wave from the contact surface between the mover gas and the target gas in an electromagnetic shock tube was studied, as well as the instabilities of the surface when these gases have different densities. The mover gas is a helium or argon plasma created by a high-voltage discharge in a magnetic field and injected into the shock tube. The target gas is either helium or argon. (France)

28304 PLASMA PRODUCTION WITH A MULTIBEAM LASER SYSTEM. Mead, S. W. (Univ. of California, Livermore). Phys. Fluids; 13: 1510-18(Jun 1970).

A multibeam laser system was used to produce spherical plasmas whose energies and growth rates were compared with the results of machine computations. The laser system was designed to provide twelve simultaneous laser pulses that can be focused symmetrically on a common point in a gas-filled target chamber. Under typical operating conditions, a total energy of about 2 J in approximately 10 nsec was directed at targets of deuterium, hydrogen, and helium at atmospheric pressure. A multiple pulse schlieren system, utilizing light from the laser oscillator, was used to measure the growth rates of the shock waves associated with the expanding plasmas. The data were compared with computational results obtained using a one-dimensional machine code that treats the formation, heating, and hydrodynamic development of laser-produced plasmas. The measured growth rates are found to be in quite good agreement with the computed results and with the behavior expected on the basis of Taylor's blast wave theory. (auth)

Stability

28305 (AD-700106) DYNAMIC STABILITY OF CLOSED PLASMA CONFIGURATIONS. Wells, Daniel R. (Miami Univ., Coral Gables, Fla. Plasma Physics Lab.). Nov 1969. 35p. (MIAPH-PP-69,17; AFOSR-70-93-TR). CFSTI.

The global stability of closed plasma configurations is related to the dynamical principle of least constraint. This principle leads to an entirely new concept of MHD stability, which is more basic than stability predictions that rely on a linearized perturbation analysis. The predictions of the theory are compared to recent experimental results obtained in studies of the stability of plasma confinement geometries. The theory predicts the violent "instabilities" of these systems that are currently attributed to other mechanisms. Several pertinent details of the theory that are widely misinterpreted are discussed and clarified. (auth) (USGRDR)

28306 (AD-701401) STABILITY OF HIGH-FREQUENCY OSCILLATIONS IN ARBITRARY PLASMA CONFIGURATIONS. Kuhn, Siegbert (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). 24 Dec 1969. Contract F61052-67-C-0014. 27p. (UNICP-SR-68; AFOSR-70-391-TR). CFSTI.

The application of a theory devised by Taylor and Hastie to the range of high-frequency oscillations in a fully ionized plasma is discussed. The shapes of both the perturbances and the equilibria on which they are superimposed are left geometrically arbitrary, and collisions are accounted for by means of a Krook-type collision term. The linearized Boltzmann equation is solved for the perturbed distribution function in the lowest order with respect to a small expansion parameter, and a generalized dispersion relation is derived by means of Poisson's equation. Then Nyquist plots are used to determine whether or not this relation is satisfied for some omega located in the "unstable" lower omega half-plane. Important general properties of the relevant Nyquist plots are stated, and a more detailed expression is given for the collisionless case. (auth) (USGRDR)

28307 (AD-701453) INVESTIGATIONS ON PLASMA INSTABILITIES AND ON MHD APPLICATIONS. Final Report, 1967-69. Cap, Ferdinand; Auer, Gerhard; Bresgen, Helmut; Falser, Helmut; Floriani, Dietmar (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). 31 Dec 1969. Contract F61052-67-C-0014. 153p. (UNICP-FR-69; AFOSR-70-387-TR). CFSTI.

Theoretical investigations on plasma instabilities appearing in dynamic equilibrium configurations of thermonuclear power and propulsion devices are described. Zeroth-order diffusion velocities due to the geometry of the confining magnetic field and due to the transport properties of the plasma variable in space and time, and the finiteness of these devices introduces new types of instabilities of nonlinear nature. Therefore, the nonlinear development of nonperiodic large-amplitude disturbances of the field quantities is investigated for nearly collisionless, collision-dominated and magnetohydrodynamic plasmas. The report gives summaries on Helmholtz instabilities, on instabilities in dissipative plasmas, on applying Lyapunov's theory to stability problems in plasma physics, on drift waves, and on micro instabilities in arbitrary geometrical configurations. Furthermore, summaries on the local efficiency of MHD generators and on similarity transformations in magnetogasdynamics are given. (auth) (USGRDR)

28308 DRIFT-WAVE INSTABILITY IN THE MODEL OF A PERIODIC SLAB. Rohlena, K. (Inst. of Physics, Prague). Plasma Phys.; 11: 751-61(Sep 1969).

The usual two-dimensional slab model with its magnetic field modulated by a small periodic part was used to examine properties of the drift modes in the plasma of an average magnetic well, e.g., multipole. There is no shear or rotational transform. The aim is a detailed examination of the effects caused by mirroring of the resonant electrons. It is found that a class of standing modes exists, out of which the mode with largest growth rate is an odd mode with wavelength double the connection length. The value of the growth rate of this mode, which concentrates in the high-field regions, is given in the limit of strong electron mirroring. (auth) (UK)

28309 NUMERICAL SIMULATION OF IONIZATION INSTABILITY. Legyel, L. L. (Institut fuer Plasmaphysik, Garching, Ger.). Energy Convers.; 10: 1-5(Mar 1970).

The possibility of numerical simulation of ionization instability observed in partially ionized nonequilibrium MHD plasmas is discussed. A mathematical model is presented in which a localized perturbation is applied to an initially homogeneous plasma enclosed by physical boundaries. The plasma may be in a stable or metastable condition depending upon the strength of the applied magnetic field. The time development of the disturbance is followed up in the nonlinear domain by numerical means. At low magnetic field strengths, the disturbance was found to disappear from the field within the first 50 to 80 μsec. At higher magnetic field strengths, the disturbance develops into well defined striae whose physical characteristics (direction, wavelength, propagational velocity) agree well with experimental observations. (auth) (UK)

28310 NONLINEAR FLUTE OSCILLATIONS OF A RAREFIED PLASMA. Dnestrovskii, Yu. N. (Moscow State Univ.); Kostomarov, D. P.; Telegin, V. I.; Panov, D. A.; Chuyanov, V. A. Plasma Phys.; 11: 691-705(Sep 1969).

The nonlinear evolution of unstable flute oscillations of a cylindrical plasma is investigated. By applying numerical methods to this problem it is shown that for a density slightly above critical, large-amplitude oscillations stabilize the instability. When this happens the ion and electron density waves form two eccentrics that rotate in anti-phase with the same frequency and amplitude; there is no substantial ejection of plasma to the wall and the plasma motion as a whole is laminar. Experiments carried out on the OGRA-II machine are in good accord with the calculations. (auth) (UK)

28311 EXPERIMENTAL INVESTIGATION OF A LOW-FREQUENCY INSTABILITY IN A MODIFIED PENNING DISCHARGE (Q-PIG). Klan, F. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch.; 25a: 263-73(Feb 1970).

Low frequency oscillations observed in a modified PIG discharge were identified as fluctuations of the electron temperature. These oscillations only occurred under certain conditions (low gas pressure, relatively high magnetic field), whereas at

high pressure and low magnetic field strength the plasma was remarkably stable; this is why the discharge is referred to as a "quiescent" PIG (Q-PIG) discharge. Measurements for obtaining a detailed picture of the two modes of the discharge are described. A qualitative explanation of the phenomena observed is obtained using the energy balance of the electron gas. (auth)

28312 FREQUENCY CUSP: MEANS FOR DISCRIMINATING BETWEEN CONVECTIVE AND NONCONVECTIVE INSTABILITY. Derfler, Heinrich (Stanford Univ., Calif.). Phys. Rev., A; 1: 1467-71(May 1970).

The colliding-pole criterion for determining instability types from dispersion relations calls for a process of conformal mapping from the frequency plane into the wave-number plane. It is shown that this process can be inverted by mapping lines, parallel to the imaginary axis, from the wave-number plane into the frequency plane. Lines mapping into a cusp locate the frequencies at which the group velocity vanishes. These frequencies determine the instability character of the system. (auth)

28313 INSTABILITY OF A WEAKLY-INHOMOGENEOUS PLASMA WITH TWO SPECIES OF IONS IN THE ABSENCE OF A MAGNETIC FIELD. Gurevich, L. E.; Vagner, I. D.; Ioffe, I. V. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR)(Engl. Transl.); 11: 30-2(5 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu; 11: 49-52(5 Jan 1970).

It is shown that in a plasma containing two species of ions, instability in the absence of a magnetic field is possible, if the electron mobility depends on the coordinates. This can be caused by the coordinate dependence of the effective electron temperature, leading to quasi-neutral density and field oscillations. Equations are derived and applied to a gas discharge in a cylindrical tube. (D.L.C.)

28314 STABLE CURVED THETA-PINCH PLASMA IN A SERIES OF CAULKED CUSP FIELDS. Uchida, Taijiro; Akiyama, Riuichi (Nagoya Univ., Japan). Phys. Rev. Lett.; 24: 1157-9 (25 May 1970).

Curved theta-pinch experiments show that a toroidal drift of plasma is suppressed by a series of caulked cusp fields, produced with the aid of metal rings located inside the discharge tube. The introduction of rings is effective in the suppression of toroidal drift of the initial high-beta plasma, as well as in the stabilization of low-beta plasma in the later stage. (auth)

28315 FEEDBACK SUPPRESSION OF COLLISIONLESS, MULTIMODE DRIFT WAVES IN A MIRROR-CONFINED PLASMA. Lindgren, N. E.; Birdsall, C. K. (Univ. of California, Berkeley). Phys. Rev. Lett.; 24: 1159-61(25 May 1970).

Simultaneous suppression of several unstable drift wave modes in a collisionless plasma was achieved using several independent feedback systems, each one tuned to a different mode. This is an improvement over broadband systems in which suppression of one mode has generally led to enhancement of other modes. (auth)

28316 STABILITY OF FINITE PRESSURE PLASMA WITH ANISOTROPIC ELECTRON VELOCITY DISTRIBUTION. Egorenkov, V. D.; Stepanov, K. N. (Inst. of Physics and Tech., Kharkov. Inst. of Physics and Tech., Sukhumi, USSR). Ukr. Fiz. Zh.; 15: 325-30(Feb 1970). (In Russian).

The stability of a uniform finite-pressure plasma with hot electrons and cold ions is considered, using an anisotropic electron distribution function. It is shown that in a high-frequency band ($\omega_{He} \gg |\omega| \gg \omega_{Hi}$), the region of instability for electromagnetic waves, which are analogous to whistlers and ion-acoustic waves, coincides with that for diamagnetic and firehose instabilities. Growth rates of the unstable oscillations considered are essentially greater than the ion-cyclotron frequency, therefore these instabilities are more dangerous than the diamagnetic and firehose ones for which the growth rates are considerably less than ω_{Hi}. (auth)

28317 PLASMA EQUILIBRIUM IN VINTOTRON. Aleksin, V. F.; Shishkin, A. A. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh.; 15: 318-24(Feb 1970). (In Russian).

Low-β plasma equilibrium was investigated in a vintotron—trap of stellarator type—the magnetic configuration of which is created by a large longitudinal field, three-turn helical magnetic field, and field of an axial current. On the basis of magnetohydrodynamic equations, the expression is obtained for equilibrium plasma pressure as dependent on vintotron parameters. (auth)

28318 SIMPLIFIED DERIVATION OF THE CONDITION FOR ELECTROTHERMAL INSTABILITY. Gilpin, R. R. (Univ. of Toronto). Phys. Fluids; 13: 1642-3(Jun 1970).

The electrothermal instability is interpreted in terms of a generalized form of the classical condition for instability in a gas discharge, that is, if $dE/dJ \leq 0$, instability occurs. (auth)

28319 GRAVITATIONAL INSTABILITY OF A ROTATING ANISOTROPIC PLASMA WITH HALL'S EFFECT. Ariel, P. D. (Malaviya Regional Engineering Coll., Jaipur, India). Phys. Fluids; 13: 1644-6(Jun 1970).

For perturbations parallel to a magnetic field, the Hall effect together with rotation suppresses the wavelength band for which the overstability can occur. Criteria of instability are derived for perturbations transverse to the magnetic field. (auth)

28320 VLASOV EQUILIBRIA AND STABILITY OF AN ELECTRON GAS. Davidson, Ronald C.; Krall, Nicholas A. (Univ. of Maryland, College Park). Phys. Fluids; 13: 1543-55(Jun 1970).

Self-consistent Vlasov equilibria with space charge are constructed for a pure electron gas radially confined in a uniform external magnetic field. A sufficient condition is obtained for the stability of these nonuniform equilibria to electrostatic perturbations. For the case in which the electron density is constant in the column interior, the dispersion relations for small-amplitude interior perturbations, electrostatic and electromagnetic, are shown to be similar in structure to the corresponding results for a neutral plasma. Algorithms are given for obtaining electron gas stability information from the neutral plasma literature. (auth)

28321 COMPARISON OF DUPREE'S PERTURBATION THEORY FOR PLASMA TURBULENCE WITH QUASILINEAR THEORY. Gratzl, H. (Univ. of Maryland, College Park). Phys. Fluids; 13: 1556-9(Jun 1970).

In a weakly turbulent plasma, Dupree's perturbation theory adds a new nonlinear interaction to the quasi-linear equations. The new term is not a higher-order correction of the quasi-linear theory as others that are recovered by Dupree's theory. (auth)

28322 THEORY OF STRONG TURBULENCE IN PLASMAS. Ichimaru, Setsuo (Univ. of Illinois, Urbana). Phys. Fluids; 13: 1560-72(Jun 1970).

A theory of fluctuations that may be applicable to a plasma in any of the three states, namely, the quiescent, weakly turbulent, and strongly turbulent states, is obtained from an exact solution of the second equation of the Bogolyubov–Born–Green–Kirkwood–Yvon hierarchy for the stationary values of the pair correlation function. A salient feature of the theory is an explicit recognition of the fact that the effective interactions between two particles may be drastically modified because of the presence of strong correlations in a turbulent plasma. As a consequence of such a modification a significant change in the frequency wavenumber dispersion relationship of the collective mode may take place in such a way that the fluctuations with macroscopic intensities can coexist in a stable manner with the given single-particle distributions; this point is specifically illustrated by means of two examples (the cold beam–plasma system and the ion–acoustic wave instability) of turbulent plasmas. The possible existence of size effects in the plasma turbulence is also discussed. (auth)

28323 CRITICAL CONDITION FOR THE ELECTROTHERMAL INSTABILITY IN A PARTIALLY IONIZED PLASMA. Hiramoto, Tatsumi (Japan Atomic Energy Research Inst., Tokai). Phys. Fluids; 13: 1492-8(Jun 1970).

It is known that an electrothermal instability arises in nonequilibrium partially ionized plasmas subjected to crossed electric and sufficiently high magnetic fields. A linear theory is applied to investigate the properties of instability waves in the vicinity of the critical condition, considering the damping factor due to electronic heat conduction and radiative transfer, and also the phase shift between the variations in the electron temperature and density. There are two kinds of electrothermal instabilities: one is the normal ionization instability and the other is a radiative instability, which can arise even in the case of no magnetic field. In the former, the largest growth rate occurs for a wave with the wavelength comparable to the characteristic length of the device. The latter has sufficiently long wavelengths compared with the length of the device. The critical Hall parameter below which instabilities do not arise increases as the size of the device containing plasmas becomes larger or the plasma pressure rises. (auth)

28324 RAYLEIGH–TAYLOR INSTABILITY OF A ROTATING HYDROGEN ARC IN AN AXIAL MAGNETIC FIELD. Doebele, H. F. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Naturforsch.; 25a: 273-82(Feb 1970). (In German).

The Rayleigh–Taylor instability of rotating hydrogen arc in an axial magnetic field is investigated with allowance for electrical

conduction, heat conduction, and viscosity. The r-dependent part of the perturbation is assumed to be in the form of a half-period of a standing wave. The corresponding dispersion relation is derived in the WKB approximation and is solved numerically. In contrast with the case without dissipation, the frequencies and growth rates of the different modes depend on the parameters of the unperturbed plasma column. The calculation shows, in qualitative agreement with the experiment, that with increasing magnetic field the highest growth rate passes successively to the next higher mode. (auth)

28325 EFFECT OF IONIZED OSCILLATIONS ON CURRENT-INTERCHANGE INSTABILITY OF A POSITIVE COLUMN. Nedospasov, A. V. Zh. Eksp. Theor. Fiz.; 58: 1310-17(Apr 1970). (In Russian).

Current-interchange instability of a gas-discharge positive column is considered theoretically by taking into account variation of the number of ionizations per plasma electron. The results agree with the main experimental facts pertaining to turbulent columns in strong magnetic fields. It is shown that, in conditions when the electron energy distribution function depends on the plasma concentration, the stability of the positive column decreases. (auth)

28326 EXPERIMENTAL OBSERVATION OF THE DRIFT-DISSIPATIVE INSTABILITY IN AFTERGLOW PLASMAS. Alcock, M. W.; Keen, B. E. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., A (London); 3: L21-3(May 1970).

Results that support the general shape of the ω-against-k_z dispersion curve for the drift-dissipative instability, predicted using the "two-fluid" equations in slab geometry, are presented. The wave is observed to be self-excited in the k_z region where a positive growth rate is predicted. (auth) (UK)

Thermonuclear Processes

Refer also to abstract 28226.

28327 (CONF-691108-2) THE FUSION TORCH: A NEW APPROACH TO POLLUTION AND ENERGY USAGE. Eastlund, Bernard J.; Gough, William C. (Division of Research (AEC), Washington, D. C.). 7 Nov 1969. 27p. Dep. CFSTI.

From 62nd Annual Meeting on Waste Treatment Applications of Radiation Chemistry, Washington, D. C.

A new concept is described for the handling of large volumes of solid wastes in the future. The energy and material balance for processing U. S. municipal wastes in the year 2000 via this concept is compared with that for advanced incineration. Background discussion of the properties of a fusion plasma and a future fusion power system are given. (M.O.W.)

28328 (JPRS-49859) DEVELOPMENT OF CONTROLLED THERMONUCLEAR SYNTHESIS RESEARCH IN THE UKRAINE, 1957-1968. Tolok, V. T. Translated from Visn. Akad. Nauk Ukr. RSR; No. 5, 24-30(1969). 9p. CFSTI.

A brief review of the various experimental programs underway and chief personnel involved is given. (M.O.W.)

28329 (ORNL-TM-2822) PRELIMINARY APPRAISAL OF THE HAZARDS PROBLEMS OF A D-T FUSION REACTOR POWER PLANT. Fraas, A. P.; Postma, H. (Oak Ridge National Lab., Tenn.). May 1970. Contract W-7405-eng-26. 32p. Dep. CFSTI.

A preliminary assessment of the hazards problems of a D-T fusion reactor was made to provide some notion of the seriousness of these problems in possible future applications of thermonuclear power plants. The inherent characteristics of magnetically confined plasmas appear to be such that any tendency toward general power overshoots or local hot spots will be more than compensated by other factors, so that there should be no difficulties with either general or local temperature or power excursions that might cause a meltdown or an explosion. In turning to radiological hazards, the principal source of concern is tritium. Fortunately, fusion reactor systems will ordinarily be designed so that the bulk of the tritium produced will be consumed as fuel. Thus, though the tritium production rate will run roughly 1000 times that in a fission reactor, by proper plant design the tritium inventory can be kept to about the same level as in a conventional fission reactor such as a PWR. Inasmuch as the tritium leakage rate from the plant depends on the inventory, it appears that the tritium leakage problem is thus roughly comparable for fission and fusion plants. However, the fusion reactor has the additional advantage that the tritium can be kept from mixing with water so that, in the fusion reactor concept considered here, one is not confronted with the choice of either sequestering large volumes of dilute aqueous solutions or employing an isotope separation process. (auth)

28330 (ORNL-TM-2932) COMPARISON OF TWO TRITIUM REMOVAL SYSTEMS DESIGNED TO MINIMIZE CONTAMINATION OF STEAM SYSTEMS IN FULL-SCALE THERMONUCLEAR POWER PLANTS. Fraas, A. P. (Oak Ridge National Lab., Tenn.). May 1970. Contract W-7405-eng-26. 28p. Dep. CFSTI.

Questions raised relative to the reactor safety and environment pollution problems of a controlled fusion reactor led to a critical examination of systems designed to recover tritium from the tritium breeding blanket. Attention was directed primarily at the extent to which the system would permit tritium to diffuse into the steam system of the power plant where it could lead to radiological contamination problems. Two systems were examined in detail. Both take advantage of the low solubility of tritium in the potassium of a potassium-steam binary vapor cycle. The first depends on removal of tritium as a noncondensable from the potassium condenser; the second employs cold traps. The cold trap system is more attractive because it gives a lower tritium leakage rate to the steam system, a lower tritium inventory, and a lower system cost. A major facet of the study entailed an examination of the effects of uncertainties in the interpretation and extrapolation of the limited data available on the permeation of hydrogen through materials. This work showed that both systems studied give acceptable tritium leakage rates into the steam system if the available data are interpreted optimistically, but only the cold-trapping system is acceptable if the data are interpreted pessimistically. (auth)

28331 (TID-25412) THE FUSION TORCH: UNIQUE APPLICATION OF ULTRA-HIGH TEMPERATURE PLASMAS. Eastlund, Bernard J.; Gough, William C. (Division of Research (AEC), Washington, D. C.). 18 Aug 1969. 24p. Dep. CFSTI.

The physics of the interactions in a fusion torch is discussed. Specific applications of the fusion torch such as material processing and ultraviolet radiation production are discussed. (M.O.W.)

28332 (UCRL-50807) A PULSED DIVERTER AND GUIDE FIELD FOR THE SUPERCONDUCTING LEVITRON. Lauer, E. J. (California Univ., Livermore. Lawrence Radiation Lab.). 13 Feb 1970. 9p. Dep. CFSTI.

The design of a pulsed diverter and guide field for the Superconducting Levitron is optimized so that a maximum area at the remote end of the guide field coil is bounded by magnetic flux lines which lie on useful flux surfaces in the Levitron. The guide field is compensated for the fringe field of the Levitron. Flux lines are followed using a numerical calculation. For torus currents corresponding to 300 kA in the floating ring, a guide solenoid current producing about 15 kG results in the above area being about 2 or 3 cm by 4 or 5 cm. (auth)

28333 A COMPUTATIONAL STUDY OF THE NEGATIVE MASS INSTABILITY IN THE NONLINEAR REGIME. Grewal, Mahesh S.; Byers, Jack A. (Univ. of California, Livermore). Plasma Phys.; 11: 727-38(Sep 1969).

Negative mass instability via numerical computations is investigated for the case of a cylindrical relativistic beam gyrating within two perfectly conducting cylinders concentric with the beam. The growth of the instability was followed into the nonlinear regime up to the point of saturation. The investigations show that as a result of this instability the beam breaks up into azimuthal clumps, with final field energies in radial electric field and the magnetic field produced by the beam increased by an order of magnitude over their equilibrium starting values. The results presented include the growth of the electric field energy and beam configurations during the development of the instability for various values of charge density in the beam and the beam thickness. (auth) (UK)

28334 CLOSED SPATIALLY PERIODIC MAGNETIC MINIMUM-B CONFIGURATIONS. Glagolev, V. M. (Kurchatov Inst. of Atomic Energy, Moscow). Plasma Phys.; 11: 621-44 (Aug 1969).

Closed magnetic traps with average minimum-B, consisting of separate stabilizing elements connected in series in a predetermined order, are considered. The minimum-B is achieved by extending the central magnetic lines of force relative to those at the periphery. (auth) (UK)

28335 ENERGY BALANCE IN A DENSE FUSION PLASMA CONTAINED BY WALLS. Alikhanov, S. G.; Konkashbaev, I. K.; Chebotaev, P. Zh. (Inst. of Nuclear Physics, Novosibirsk, USSR). Nucl. Fusion; 10: 13-18(Mar 1970).

The possibility of self-sustaining thermonuclear reaction in a dense plasma ($n \geq 10^{16}$ cm^{-3}) is considered. The pressure of the plasma is contained by walls and the magnetic field only serves

to reduce thermal conductivity in a transverse direction. A solution is obtained for the plasma balance equation that makes allowance for radiation losses along the magnetic field, and it is shown that there is no satisfactory solution across a uniform magnetic field. The possibility of a steady-state thermonuclear reaction with a nonuniform magnetic field is discussed. (auth)

28336 RECENT WORLD DEVELOPMENTS IN CONTROLLED FUSION. A LECTURE. Bishop, A. S. (Atomic Energy Commission, Washington, D. C.). Nucl. Fusion; 10: 85-93(Mar 1970).

Some of the highlights of the scientific and technological developments that have occurred in the field of controlled fusion during the last several years are summarized. The general topics discussed are the following: Low-beta open-ended configurations; high-beta systems—open and closed; low-beta toroidal systems; and considerations regarding full-scale fusion reactors. (M.O.W.)

28337 SHEAR AND MINIMUM $\bar{B}$ IN MAGNETIC CONFIGURATIONS WITH COMBINED HELICAL FIELDS. Loktionov, Yu. M.; Sebko, V. P. (Inst. of Technical Physics, Kharkov). Nucl. Fusion; 10: 29-35(Mar 1970).

As asymmetric arrangement of the conductors of a helical stellarator winding and currents passing through them unequal in absolute value cause the formation of a spatial magnetic axis. In the vicinity of this axis the useful volume bounded by a certain surface exhibits the principal properties needed to stabilize a number of plasma instabilities—shear and minimum $\bar{B}$. A detailed analytical study of asymmetric systems of this kind is presented here. It is demonstrated that the use of the second and third harmonics of a helical magnetic field in devices with a high aspect ratio makes it possible to obtain $\delta V'/V'$ between 0.08 and 0.15 for shears $S^* = 0.05$ and 0.13 and a useful volume of sufficient size. The configurations considered can be used to create closed magnetic traps for the purpose of confining a high-temperature plasma and studying the stabilizing effect on it of shear and minimum $\bar{B}$, both together and separately. (auth)

28338 APPARATUS FOR THE STABLE CONFINEMENT OF A PLASMA. Braams, Cornelis Marius (to Stichting voor Fundamenteel Onderzoek der Materie). U. S. Patent 3,508,104. 21 Apr 1970. Filed 3 Jul 1967.

A plasma is stabilized against MHD and velocity-space instabilities by being confined by a cold gas blanket in a toroidal magnetic field. A ring whirl helps to define the equilibrium position, to stabilize against deviations from the steady-state, and to allow a poloidal field component. (auth)

28339 THE DIFFERENCE BETWEEN ELECTRON GAS AND ION GAS TEMPERATURE IN A FUSION PLASMA. Valentini, H.-B. (Institut fuer Magnetohydrodynamik, Jena, Ger.). Kernergie; 13: 25-30(Jan 1970). (In German).

Thermalization of fast ions in the fusion plasma, heat exchange between electron gas and the individual components of the ion gas, and temperature difference between electron gas and ion gas were calculated approximately for a simple steady-state fusion reactor model. In an isothermal deuterium plasma, the thermalization time of the ions formed during the nuclear reactions is more than 20 times smaller than the optimum mean confinement time when plasma temperature is within the optimum fusion range of about 80 keV. The kinetic energy of very fast ions, for the most part, goes directly to the electron gas. In D–D reactors with isothermal plasma at optimum temperature the part of fusion energy going directly to the electron gas overcomes that directly transferred to the ion gas and increases with decreasing electron temperature at constant ion temperature and constant composition of the plasma. If the fusion plasma is directly heated by the ions formed in nuclear reactions, the electron temperature may surmount that of the ions in reactors, in which the D–^{3}He reactions essentially contribute to energy generation, although the electron gas is heavily cooled by radiation losses. In a reactor fed by deuterium only, the difference between ion and electron temperatures is low for "direct" heating of the plasma within the optimum range of ion temperature and of the product of particle density by mean confinement time. The latter conclusion does not apply to magnetic mirror bottles. (auth)

28340 RESEARCH ON THE ROD PLASMA INJECTOR (RPI). Gryzinski, Michal; Nowikowski, Jerzy; Sadowski, Marek; Skladnik-Sadowska, Elzbieta (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 14: 885-92(Oct 1969).

The basic results of experimental studies conducted on a new type plasma injector (RPI) are presented. The design of the RPI as well as the experimental arrangement is described. The results of measurements using a high-speed camera, magnetic probes and spectroscopic methods are given. It has been proved that, under properly chosen experimental conditions, a strong concentration of plasma can be obtained on the axis of the injector. (auth)

Wave Phenomena

Refer also to abstract 28285.

28341 (AD-701402) NORMAL MODES FOR DRIFT WAVES IN ADIABATIC PLASMAS. Auer, Gerhard (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). 20 Dec 1969. Contract F61052-67-C-0014. 19p. (UNICP-SR-69; AFOSR-70-390-TR). CFSTI.

The normal modes for electrostatic waves in an inhomogeneous low-β plasma are investigated under the assumption of adiabatic oscillations. A two-fluid model is used and electron inertia and finite electrical conductivity are taken into account. The dispersion relation obtained is discussed for the limits of perpendicular and nearly parallel propagation, respectively, with respect to the magnetic field. For small parallel wavenumbers the dispersion relation is discussed numerically and dispersion curves are obtained. It is found that the modes present in an isothermal plasma are only slightly changed. Besides them, two new drift waves occur that are stable according to linear theory. For sufficiently large parallel wavenumbers they go over into acoustic waves. (auth) (USGRDR)

28342 (N-70-17635) CLOSED-FORM APPROXIMATE SOLUTIONS TO THE OSCILLATORY PLASMA CONTINUITY EQUATIONS. Nichols, Lester D.; Roth, J. Reece (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan 1970. 10p. (NASA-TM-X-1944). CFSTI.

Recent experimental observation of continuity-equation plasma oscillations has made desirable an improved closed-form approximation to the nonlinear differential equations which describe them. Such an approximation is presented here and is compared with the less-satisfactory approximations previously obtained and also with the exact solutions to these equations obtained by numerical integration. (auth) (STAR)

28343 (N-70-19273) ORDINARY-MODE ELECTROMAGNETIC INSTABILITY IN COUNTERSTREAMING PLASMAS WITH ANISOTROPIC TEMPERATURES. Bornatici, M.; Lee, Kai Fong (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan 1970. 27p. (NASA-TM-X-63824; X-640-70-21). CFSTI.

The instability of the electromagnetic linearly polarized mode propagating perpendicular to a uniform magnetic field is studied by using the Vlasov equation for a counterstreaming electron plasma with anisotropic temperatures. An instability occurs if the streaming velocity exceeds a certain threshold value that can be below that required to excite the electrostatic two-stream instability. It is found that temperature perpendicular to the field has a stabilizing effect, while parallel temperature enhances the electromagnetic instability. Typical growth rates are of the order of the electron cyclotron frequency. (auth) (STAR)

28344 PROPAGATION OF IONIZATION WAVES. Munt, R. (Univ. of Michigan, Ann Arbor); Ong, R. S. B.; Turcotte, D. L. Plasma Phys.; 11: 739-49(Sep 1969).

A nonlinear analysis of ionization wave fronts is given including energy effects. The necessary external energy source is Joule heating due to an applied transverse electric field. The front propagates at a speed which is proportional to the product of the electron sound speed and the square root of the ratio of the electron collision time to the reaction time. The structure of the ionization wave is also obtained. (auth) (UK)

28345 EXPERIMENTAL OBSERVATION OF CONTINUITY-EQUATION OSCILLATIONS IN SLIGHTLY IONIZED DEUTERIUM, NEON, AND HELIUM GAS. Roth, J. Reece (Lewis Research Center, Cleveland). Plasma Phys.; 11: 763-77(Sep 1969).

Low-frequency oscillations in the electron number density of slightly ionized deuterium, neon, and helium were systematically observed over the frequency range from 10^2 to 8×10^4 Hz. These oscillations can be identified with periodic solutions to the neutral- and charged-particle continuity equations. The frequency of the oscillation was observed to be independent of magnetic field strength, and to have the predicted square-root dependence on the product of electron and neutral number density. The continuity-equation oscillation mechanism was observed over more than five orders of magnitude in this product. (auth) (UK)

28346 PARAMETRIC EXCITATION OF LOW FREQUENCIES IN A BOUNDED PLASMA. Demokan, O. (Univ. of Iowa, Iowa

City); Hsuan, H. C. S.; Lonngren, K. E.; Stern, R. A. J. Appl. Phys.; 41: 2122-7(Apr 1970).

The coupling of an incident microwave signal in a Tonks–Dattner resonance to discrete low-frequency modes in a plasma column is presented both theoretically and experimentally. The necessary conditions that the incident power and frequency had to meet in order to excite these modes are also explained and experimentally tested. (auth)

28347 NONLINEAR QUASI-NEUTRAL ELECTROSTATIC PLASMA WAVES AND SHOCK WAVES. Tasso, Henri (Institut fuer Plasmaphysik, Munich). Plasma Phys.; 11: 663-7(Aug 1969).

For the stationary one-dimensional Vlasov equation, quasi-neutrality is used instead of the Poisson equation. This allows one to obtain explicit solutions for the density as a function of the potential and to prove the positiveness of the trapped-particle distribution function in a potential interval. This method has obvious application to oscillatory waves and shock waves. (auth) (UK)

28348 INTERACTION OF MAGNETOHYDRODYNAMIC WAVES IN A BOUNDED PLASMA. Karplyuk, K. S.; Kolesnichenko, Ya. I.; Oraevskii, V. N. (Inst. of Physics, Kiev). Nucl. Fusion; 10: 3-11(Mar 1970).

A general method of deriving dynamic equations for the amplitudes of interacting waves (both volume and surface waves) in a bounded plasma is described. The treatment is based on the study of the interaction of magnetohydrodynamic waves in a plasma cylinder confined by a strong magnetic field. Decay instabilities were studied in order to find the probabilities and evaluate the characteristic times of the corresponding three-plasmon processes. It is shown that the nonlinearity of the boundary conditions can have a substantial effect on three-plasmon interactions involving surface waves. The linear problem was solved in advance. It is shown, in particular, that in addition to the Alfvén surface waves, acoustic-type surface waves with frequencies approximately equal (when $\beta = p_0/(H^2/8\pi) \ll 1$) to $\sqrt{2}\omega_A$ (ω_A being the Alfvén frequency) can propagate in the plasma cylinder. (auth)

28349 FORWARD AND BACKWARD BERNSTEIN WAVES. Leuterer, F. (Institut fuer Plasmaphysik, Munich). Plasma Phys.; 11: 615-20(Aug 1969).

An experiment is described in which the superposition of long- and short-wavelength Bernstein waves in a low-density ($\omega_p^2/\omega^2 < 1$) magnetoplasma was observed. The waves were identified as forward and backward waves respectively. (auth) (UK)

28350 WAVE PROPAGATION IN A WEAKLY TURBULENT MAGNETIZED PLASMA. Fidone, Ignazio (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). Plasma Phys.; 11: 669-80(Aug 1969).

The propagation of a high-frequency electromagnetic wave in a weakly turbulent magnetized plasma is studied. The turbulent regime satisfies the quasi-linear equations and arises from low frequency microinstabilities. The index of refraction of an extraordinary wave propagating across the constant magnetic field is discussed in detail. It is shown that for an axially symmetric turbulent spectrum generated by ion cyclotron waves there is a symmetrical shift of the resonance frequency. (auth) (UK)

28351 EXACT, STATIONARY TRANSVERSE WAVE SOLUTION OF THE NONLINEAR, RELATIVISTIC VLASOV EQUATION. Abraham-Shrauner, B. (Washington Univ., St. Louis). Plasma Phys.; 11: 687-9(Aug 1969).

The results of an analysis of stationary, transverse, electromagnetic waves as exact solutions of the nonlinear Vlasov equation (Abraham–Shrauner, 1968) are extended to the relativistic regime. (auth) (UK)

28352 FINITE-AMPLITUDE SOLUTION OF THE SELF-CONSISTENT VLASOV EQUATIONS. Luenow, W. (New Mexico State Univ., Las Cruces). Z. Naturforsch.; 25a: 164-9 (Feb 1970).

The propagation of a finite-amplitude circularly polarized electromagnetic plane wave through a fully ionized hot collisionless plasma, composed of Q ($\geq$1) types of ions and of electrons, was studied as a strict solution of the nonrelativistic self-consistent Vlasov equations within the scope of some given applicability criterions. A constant magnetic field and a constant total plasma stream, both parallel to the wave propagation direction, are allowed. Wave propagation and particle motion are separately discussed. Particularly, the possible existence of an anomalous wave, propagating with light speed through multicomponent (Q > 1) plasmas with arbitrary ratios plasma frequency/wave frequency, and the possible existence of multicomponent plasmas with temperatures, far below thermonuclear temperatures, but under electromagnetically generated fusion conditions, are proved. The treated solution is of physical and astrophysical interest, likewise. (auth)

28353 INTERACTION OF HIGH-FREQUENCY AND LOW-FREQUENCY WAVES IN A PLASMA. Bakai, A. S. (Inst. of Technical Physics, Kharkov). Nucl. Fusion; 10: 53-67(Mar 1970).

The interaction in a plasma between high- and low-frequency waves with given phases is considered in a three-wave approximation. The number of interacting waves is arbitrary. Linear damping of the waves is taken into account. Approximate solutions are found of the equations for the amplitudes. A criterion is established for the decay instability of a strong high-frequency wave. The author finds the equilibrium distribution of energy among the waves and the criterion for its establishment. The results are illustrated by examples of the interaction between transverse electromagnetic and Langmuir waves in a homogeneous equilibrium plasma and of the interaction of space charge waves with ion-acoustic waves in a conducting cylinder situated in a longitudinal magnetic field. Comparisons are made with experiment. (auth)

28354 PENETRATION OF AN ELECTROMAGNETIC FIELD INTO A PLASMA IN THE CASE OF A NON-LINEAR OHM'S LAW. Soldatenkov, T. R. (Inst. of Technical Physics, Sukhumi, USSR). Nucl. Fusion; 10: 69-73(Mar 1970).

The influence of ion–acoustic instability on the penetration of a high-frequency field into a plasma is investigated. The slowing-down of the plasma electrons as the instability develops is taken into account by means of a nonlinear Ohm's law $j_z = j_0[1 - \exp(-\alpha E)]$ which enables one to consider continuous variations of the depth to which the field penetrates the plasma as a function of the parameter $\alpha = E_0/E_k$, where E_0 is the peak electric field value and E_k the field value at which ion–acoustic instability occurs in the plasma. The depth of penetration by the field into the plasma is determined as a function of α. For large α the penetration depth increases by a factor $\alpha^{1/2}$ relative to the skin-layer thickness of the linear theory (where $\alpha \ll 1$). (auth)

28355 SURFACE WAVES IN A PLASMA WITH AN OSCILLATING CURRENT. I. LONG-WAVE OSCILLATIONS OF A COLD BOUNDED PLASMA. Sidorov, V. P.; Tsypin, V. S. (Inst. of Technical Physics, Sukhumi, USSR). Nucl. Fusion; 10: 75-80(Mar 1970).

The long-wave oscillations of a cold bounded plasma against a background of steady-state electron oscillations are considered. The problem is solved in a nonlinear approximation with respect to an external high-frequency field. It is found that, as in the case of a constant current, the surface waves are unstable. (auth)

28356 SURFACE WAVES IN A PLASMA WITH AN OSCILLATING CURRENT. II. PLASMA SURROUNDED BY A SHEATH OF INFINITE CONDUCTIVITY. Sidorov, V. P.; Tsypin, V. S. (Inst. of Technical Physics, Sukhumi, USSR). Nucl. Fusion; 10: 81-4(Mar 1970).

Surface waves excited in cold plasma by an oscillating current are studied considering cases where the plasma is bounded (plasma layer and plasma cylinder). It is physically clear that one has to take into account the actual geometry of the plasma configuration when the damping length of a surface wave is commensurate with the transverse dimensions of the plasma. The authors study the surface waves when the plasma is surrounded by a metallic sheath of infinite conductivity. The conditions are found for the buildup of three-dimensional surface waves and the corresponding expressions derived for their frequencies and growth rates. (auth)

28357 COMMENTS ON THE REFLECTION COEFFICIENT OF A PLASMA PROFILE OF EXPONENTIALLY TAPERED ELECTRON DENSITY AND FIXED COLLISION FREQUENCY. Wait, James R. (ESSA Research Lab., Boulder, Colo.). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation; AP-18: 297-8(Mar 1970).

Reflection of plane waves from an inhomogeneous medium is considered. It is pointed out that attempts to define a meaningful reflection coefficient within the medium are unsuccessful. On the other hand, if the observer is in the free-space region, there is a unique decomposition into traveling waves with a correspondingly unique definition of a meaningful reflection coefficient. (auth)

28358 LOW-FREQUENCY OSCILLATIONS IN A PLASMA ROTATING IN A MAGNETIC FIELD. Andropov, V. G.; Lopatskii, G. S.; Petrov, G. D.; Chernysh, V. I.; Yurchuk, E. F. Zh. Prikl. Mekh. Tekh. Fiz.; No. 5, 141-3(Sep-Oct 1969). (In Russian).

Processes in a rotating plasma were investigated by measuring simultaneously the rate of propagation of the ionization front and the frequency of oscillations induced in the plasma arc. Fluctuations of the radial and azimuthal components of the electric field and the brightness of the arc in the 6328 ± 40 Å range were used to determine the oscillation parameters of the arc, rotated by an applied magnetic field. The measurements also included determination of the amplitudes of the plasma density gradient by means of a helium–neon laser. It was found that the rate of propagation of the ionization front is very close to the rate of rotation; both the rate of rotation and the frequency of specific oscillations are linearly related to the external field. The amplitude of the density oscillations was found to be very small. (TTT)

28359 WAVE COUPLING ACROSS A SHOCK WAVE IN A VISCOUS PLASMA. Francis, Samuel H.; Kahn, David (Electronics Research Center, Cambridge, Mass.). Phys. Rev., A; 1: 1678-87(Jun 1970).

A theory of the coupling between electron–acoustic, ion–acoustic, and electromagnetic plane waves at an idealized shock front in a two-fluid, fully ionized viscous plasma is presented. The viscous-fluid equations and Maxwell's equations are used to derive the dispersion equation relating the frequency and propagation constant of possible modes of propagation in a viscous plasma. Boundary conditions which must hold at the shock front in the presence of an incoming perturbation are then derived, and the amplitudes and energies of predicted wave modes generated at the boundary are calculated. In the limit of small viscosity, the energy-coupling ratios reduce to the values found previously in the inviscid problem, and for all values of viscosity one found enhanced wave transmission as previously found in the inviscid problem. Additionally, maxima in the energy-coupling ratios are found to exist, depending upon the viscosity of the medium. (auth)

28360 DOPPLER SHIFT IN FREQUENCY IN THE TRANSPORT OF ELECTROMAGNETIC WAVES THROUGH AN UNDERDENSE PLASMA. Peacher, Jerry L.; Watson, Kenneth M. (Univ. of California, Berkeley). J. Math. Phys. (N. Y.); 11: 1496-1504 (Apr 1970).

In an earlier publication, the validity of the radiation transport theory was studied for the calculation of multiple scattering of electromagnetic waves by a turbulent plasma. In this paper, the transport theory is extended to include a description of the Doppler shift in frequency caused by electron motion. (auth)

28361 STIMULATED MODULATIONAL INSTABILITIES OF PLASMA WAVES. Hasegawa, Akira (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., A; 1: 1746-50(Jun 1970).

Nonlinear coupling of a modulated wave and a low-frequency mode is shown to produce a resonant interaction and instability when the Cherenkov condition $v_p = v_g \cos\theta$ is satisfied for the phase velocity v_p of the low-frequency mode, the group velocity v_g of the modulated wave, and the angle θ between the two wave vectors. This effect stimulates the self-trapping (modulational instability) or self-focusing of the modulated wave. Examples are shown for the cases of couplings between plasma cyclotron waves and magnetohydrodynamic (MHD) modes. (auth)

28362 SUPERLUMINOUS WAVES IN STREAMING RELATIVISTIC PLASMAS. Buti, B. (Indian Inst. of Tech., New Delhi). Phys. Rev., A; 1: 1772-4(Jun 1970).

Superluminous waves propagating transverse to the direction of relative streaming (relativistic or nonrelativistic) of a plasma are investigated in the absence of any external field. It is shown that these waves do not excite any instability, that they are essentially stable. (auth)

28363 POYNTING FLUX OF ELECTROSTATIC WAVES. Gratton, F.; Gratton, J. (Univ., Buenos Aires). Nucl. Fusion; 10: 97-8(Mar 1970).

The energy flow of electrostatic waves in cold plasma was calculated. (M.O.W.)

28364 OBSERVATION OF SELF-TRAPPING INSTABILITY OF A PLASMA CYCLOTRON WAVE IN A COMPUTER EXPERIMENT. Hasegawa, Akira (Bell Telephone Labs., Murry Hill, N. J.). Phys. Rev. Lett.; 24: 1165-8(25 May 1970).

The exact behavior of a modulated cyclotron wave in a plasma is traced in a numerical model to study the self-trapping instability represented by the nonlinear Schroedinger equation with an attractive potential. The instability is found to be explosive in that the wave collapses at a much faster rate than the prediction of the perturbation solution. (auth)

28365 PROPAGATION AND AMPLIFICATION OF ELECTROSTATIC WAVES IN AN ELECTRON BEAM–INHOMOGENEOUS PLASMA SYSTEM CONFINED BY A MAGNETIC FIELD. COMPARISON WITH A HOMOGENEOUS MEDIUM. Weinfeld, Michel; Bouchoule, Andre (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 270: 725-8(16 Mar 1970). (In French).

The phase velocity and the rate of growth of the unstable modes of an electron beam–radially inhomogeneous plasma system in an infinite magnetic field are calculated from a theory previously established. A homogeneous system is shown to have dispersive properties not very different from those of the system described here if both the frequency and the radius of the homogeneous plasma are properly chosen. (France)

28366 LOW-FREQUENCY OSCILLATIONS IN THE HOT-CATHODE PENNING DISCHARGE PLASMA. Naumovets, V. G.; Romanyuk, L. I.; Slobodyan, V. M. (Inst. of Physics, Kiev). Ukr. Fiz. Zh.; 15: 377-91(Mar 1970). (In Russian).

Low-frequency oscillations were investigated in the region of 1 to 100 kHz in the hot-cathode Penning discharge plasma. These oscillations were caused by a density wave moving in the direction of plasma drift in the crossed electric and magnetic fields. Azimuthal modes m = 1, 2, 3 were observed. The data were obtained on the dependence of critical magnetic fields for onset of oscillations with modes m = 1, 2, 3 on the discharge parameters. The regions of the discharge parameters for existence of different mode oscillations were determined. The data on behavior of the frequency and amplitude of oscillations with changing discharge conditions and on the effect of the latter on plasma parameters were obtained. Possible reasons for the onset of oscillations are under discussion. (auth)

28367 HYDROMAGNETIC OSCILLATIONS OF A TANGENTIAL DISCONTINUITY IN THE CHEW, GOLDBERGER, AND LOW APPROXIMATION. Duhau, S.; Gratton, F.; Gratton, J. (Univ., Buenos Aires). Phys. Fluids; 13: 1503-9(Jun 1970).

The differential equation for linear modes of oscillation of plane parallel flows of plasmas along an external magnetic field in the Chew, Goldberger, and Low approximation is obtained. Properties of modes for a tangential discontinuity are studied for the case when the surface is modulated along the magnetic field. Overstable modes found by other authors are shown to be spurious. Regions of existence of modes, proper frequencies, and spatial dependence of the perturbation are given. It is found that, broadly speaking, low β plasmas should be free of surface instabilities for all values of the flow velocity, whereas high β plasmas can be unstable if the flow velocity is nearly sonic. Changes in the anisotropy do not substantially affect the general picture of the problem. (auth)

28368 MULTIPLE PSEUDOWAVES PRODUCED BY A SINGLE VOLTAGE PULSE. Alexeff, I.; Jones, W. D.; Widner, M. (Oak Ridge National Lab., Tenn.). Phys. Fluids; 13: 1519-24(Jun 1970).

A multiple pseudowave—or a series of fast ion bursts—is generated when a short negative voltage pulse is placed on a transparent grid immersed in a plasma. The phenomenon resembles, but is not, a damped wave train. Using a single-particle model, it is shown that multiple pseudowaves can be explained in terms of ions trapped and oscillating in the ion sheath formed around the grid by the negative-voltage pulse. A pulsed grid used in this manner constitutes a simple diagnostic technique for measuring plasma density. (auth)

28369 ELECTROSTATIC PLASMA INSTABILITIES EXCITED BY A HIGH-FREQUENCY ELECTRIC FIELD. Sanmartin, Juan R. (Princeton Univ., N. J.). Phys. Fluids; 13: 1533-42(Jun 1970).

The electrostatic plasma waves excited by a uniform, alternating electric field of arbitrary intensity are studied on the basis of the Vlasov equation; their dispersion relation, which involves the determinant of either of two infinite matrices, is derived. For $\omega_0 \gg \omega_{pi}$ (ω_0 being the applied frequency and ω_{pi} the ion plasma frequency) the waves may be classified in two groups, each satisfying a simple condition; this allows writing the dispersion relation in closed form. Both groups coalesce (resonance) if (a) $\omega_0 \approx \omega_{pe}/r$ (r any integer) and (b) the wavenumber k is small. A nonoscillatory instability is found; its distinction from the DuBois–Goldman instability and its physical origin are discussed. Conditions for its excitation (in particular, upper limits to ω_0, k, and $k \cdot v_E$, v_E being the field-induced electron velocity), and simple equations for the growth rate are given off-resonance and at $\omega_0 \approx \omega_{pe}$. The dependence of both threshold and maximum growth rate on various parameters is discussed, and the results are compared with those of Silin and Nishikawa. The threshold at $\omega_0 \approx \omega_{pe}/r$, $r \neq 1$, is studied. (auth)

28370 PLASMA WAVE ECHO IN A WEAKLY TURBULENT PLASMA. Ichikawa, Yoshi H.; Sanuki, H. (Nihon Univ., Tokyo). Phys. Fluids; 13: 1573-9(Jun 1970).

The effects of turbulent fluctuations on the plasma wave echo

were investigated for a one-dimensional weakly turbulent electron plasma. It was found that the interaction between electrons and fluctuations give rise to (i) damping of the plasma echo, (ii) shift of the maximum position of plasma echo, and (iii) suppression of the peak intensity of plasma echo. (auth)

28371 RESONANCES AND WAVE CONVERSION BELOW THE SECOND ELECTRON CYCLOTRON HARMONIC. Kuehl, H. H. (Univ. of Southern California, Los Angeles); O'Brien, B. B.; Stewart, G. E. Phys. Fluids; 13: 1595-1608(Jun 1970).

A theory is given describing the conversion of fast-to-slow waves and vice versa, propagating perpendicular to a static magnetic field in a planar geometry for frequencies near and below the second electron cyclotron harmonic. The half-space and slab are treated with collisional effects included. It is shown that the power conversion between the two wave types is directly proportional to the scale length of the density gradient at the point in the plasma where the hybrid resonance condition is satisfied provided this scale length is small compared to a free-space wavelength. In spite of the small coupling, appreciable interaction is shown to take place between a transverse wave incident on a plasma slab and the longitudinal wave when a resonance condition exists for the longitudinal wave. The linewidth of the resonances is found to depend on both the density gradient near the hybrid resonance points and collisional effects. (auth)

28372 INVESTIGATION OF RESONANCE EXCITATION OF HIGH-AMPLITUDE WAVES IN A PLASMA. Grigor'eva, L. I.; Smerdov, B. I.; Chechkin, V. V. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz.; 58: 1234-42(Apr 1970). (In Russian).

Excitation of high-amplitude waves in a plasma cylinder is investigated experimentally for frequencies $\omega_{Hi} < \omega < (\omega_{Hi}\omega_{He})^{1/2}$. The wave is excited by a high-frequency azimuthal, axially periodic current flowing in a coil encircling the plasma. The spectrum of magnetic field oscillations, which appear in the plasma when the exciting current is switched on, is obtained. It is demonstrated experimentally that in the region of resonance excitation of a fast magneto-acoustic wave (whistle) in the plasma, besides the purely forced oscillations, two proper oscillations (whistle) are also excited, the wavelength of one oscillation and the frequency of the other differing respectively from the axial period and the frequency of the exciting current. Excitation of proper oscillations is due to the finite width of the exciting current spectra in wave number space and frequency space. It is also found that a whistle with a frequency differing from that of the exciting current decays into a whistle and a fast sound (cyclotron-sound) wave. The conditions for such decay in a bounded plasma are discussed. (auth)

28373 STRUCTURE OF RELATIVISTIC SOLITONS IN A MAGNETOACTIVE PLASMA. Zaitsev, V. V. (Gorky State Univ., USSR). Zh. Eksp. Teor. Fiz.; 58: 1359-66(Apr 1970). (In Russian).

A relativistic equation for the structure of solitons is derived in the approximation of a cold collisionless plasma in which electron inertia is neglected. A classification of possible solutions of the equation depending on the parameters of the problem is carried out. Overturning of the relativistic soliton front at high amplitudes is investigated, and the characteristic front dimensions are determined for various limiting cases. (auth)

28374 THEORY OF PLASMA ECHO. THREE-MOMENTUM ECHO OSCILLATIONS. Sitenko, A. G.; Nguyen Van Chong; Pavlenko, V. N. (Inst. of Theoretical Physics, Kiev). Zh. Eksp. Teor. Fiz.; 58: 1377-83(Apr 1970). (In Russian).

Echo oscillations in a plasma arising as the result of superposition of three consecutive perturbations separated by time intervals that are large compared with the characteristic oscillation decay time are considered. The perturbations chosen in the form of plane waves and the perturbation wave vectors are assumed to be noncollinear. Echo oscillations of the second order are therefore impossible. It is shown that echo oscillations of the third order should be possible if the perturbation wave vectors lie in a single plane. The origin time and shape of the third-order echo oscillations are found. It is shown that even in the case of longitudinal perturbations the echo oscillation field contains both longitudinal and transverse components. A number of concrete cases of appearance of third-order echo oscillations is considered. (auth)

28375 ON THE NATURE OF COLLISIONLESS "ATTENUATION" OF ELECTROMAGNETIC WAVES IN REGIONS OF STRONG INHOMOGENEITY OF A COLD PLASMA. Dolgopolov, V. V.; Omel'chenko, A. Ya. (Physical-Technical Inst. of Low Temperatures, Kharkov). Zh. Eksp. Teor. Fiz.; 58: 1384-94(Apr 1970). (In Russian).

Electromagnetic oscillations due to an initial perturbation at the boundary of a semi-infinite plasma and vacuum are investigated, taking into account finiteness of the transition zone between the homogeneous plasma and vacuum and also in a nonuniform plane parallel plasma layer in the case when the wavelength of the wave moving along the layer is much greater than the layer width. It is shown that for a period defined by the width of the inhomogeneous region, the surface waves produced by the initial disturbance completely change into Langmuir oscillations along the direction of the plasma density gradient; the oscillations are concentrated in the vicinity of the point of plasma resonance for the surface wave frequency. This region comprises a small part of the inhomogeneous region of the plasma. If the inhomogeneity region width of the medium is comparable with the wavelength, oscillations of a given frequency in general will not exist at different points of the inhomogeneous medium. In the general case (for an arbitrary ratio between the wavelength and characteristic dimension of the inhomogeneity) Langmuir oscillations (with different frequencies at various points of the inhomogeneous medium) will remain as a result of development of the initial perturbation. The effective wave vector of the oscillations along the plasma density gradient grows indefinitely with time. (auth)

28376 ON A CERTAIN METHOD IN THE THEORY OF STRONG TURBULENCY IN A PLASMA. Berman, G. P.; Zaslavskii, G. M. Zh. Eksp. Teor. Fiz.; 58: 1453-65(Apr 1970). (In Russian).

Nonlinear two-dimensional ion-acoustic motions with velocities slightly exceeding that of sound are considered. In the one-dimensional case, the approximation leads to the Korteweg-de Vries equation. In the two-dimensional case, the solution is expressed as an expansion on one-dimensional nonlinear periodic waves. The expansion parameter is a quantity that is the reciprocal of the square root of the Reynolds number analog for the given problem. The latter is assumed to be large, which signifies appreciable nonlinearity. Interaction of two nonlinear waves and resonance of three nonlinear waves are considered. A condition for randomness of the wave phase shifts is obtained for those cases when a large number of waves are excited. A master kinetic equation for an ensemble of nonlinear waves is set up. In the general case of the master kinetic equation, an exact solution for the many-particle distribution function is found which leads to a constant energy flux over the spectrum. The solution corresponds to stationary uniform turbulence and is employed for determining the turbulence spectrum. It is shown how the results obtained can be extended to the three-dimensional case. (auth)

28377 NONLINEAR RECIPROCAL ACTION AND ECHOES IN QUASI-STATIC MODES OF MAGNETOPLASMA. Sauer, K. Monatsber. Deut. Akad. Wiss. Berlin; 11: 711-23(1969). (In German).

Based on the nonlinear conduction tensor of the third degree with respect to a magneto-active plasma, the necessary nonlinear coefficients are calculated for various transformations of quasi-static modes. Mathematically treated are the reciprocal action for transformation of longitudinal into transverse waves and the scalar coefficient for transformations resulting in a quasi-static character of both field and primary wave. If spatial dispersion of the resulting transverse wave is neglected, complete integration of the velocity of reciprocal action is possible. Integration of the scalar coefficient is performed to a degree that allows discussion of echoes of quasi-static modes. (tr-auth)

28378 INFLUENCE OF QUASI-LINEAR EFFECTS ON THE FREQUENCY OF ION-ACOUSTIC OSCILLATIONS. Pyatak, A. I.; Sizonenko, V. L.; Stepanov, K. N. Ukr. Fiz. Zh.; 15: 523-5(Mar 1970). (In Russian).

Previous studies of quasi-linear effects on oscillations took into account the inverse oscillations of resonance particles, resulting in a change of the derived distribution function and less increase of oscillations. It is shown that, in the case of ion-acoustic oscillations, the inverse oscillation effect on particles results in strong changes in the characteristic frequency of oscillations. (R.V.J.)

Shielding

Refer also to abstracts 28562, 28653, and 28676.

28379 (AD-688852) CHARGE CODE FOR SPACE RADIATION SHIELDING ANALYSIS. Yucker, W. R.; Lilley, J. R.; Langley, R. W.; Klevatt, P. L. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.). Apr 1969. 214p. (DAC-62231). CFSTI.

Supersedes AD-615664.

CHARGE, a FORTRAN IV program for the analysis of primary

electron and proton or heavy charged-particle passage through plane or spherical shields containing up to 100 regions, and the attendant generation and transmission of electron-induced x rays (bremsstrahlung) and proton-induced secondary protons and neutrons are described. Proton and electron analyses use a modification of the range–energy relationship applied to as many as 100 energy groups, while the bremsstrahlung transmission calculation assumes an exponential attenuation corrected by semi-empirical dose buildup factors applied individually to a similar number of gamma ray energies. Availability of several bremsstrahlung source options permits comparison of most commonly used approximations. Energy-dependent removal cross sections are used to calculate secondary neutron transmission. (auth) (USGRDR)

28380 (AD–697908) DIFFERENTIAL NEUTRON AND SECONDARY GAMMA-RAY ALBEDOS FOR STEEL-COVERED CONCRETE SLABS. VOLUME I. DESCRIPTION OF CALCULATIONS AND COMPARISONS WITH OTHER DATA. Wells, M. B.; Marshall, J. D. (Radiation Research Associates, Inc., Fort Worth, Tex.). 10 Jul 1969. 61p. (RRA-T–97-1). CFSTI.

Calculations were performed with the two-dimensional S_n procedure DOT to determine the distribution in energy and angle of the neutrons and secondary gamma rays reflected from steel-covered concrete slabs for 27 incident neutron energy intervals ranging from 14.918 MeV to 2.53×10^{-8} MeV and for 5 incident directions. The doubly differential neutron current albedo was computed for 30 emergent directions and for each of the 27 energy intervals lying between and including the incident energy interval and 2.53×10^{-8} MeV. The secondary gamma-ray doubly-differential current albedo was computed for the same parameters as those used to define the neutron albedo except that 13 energy intervals between 10.0 MeV and 0.01 MeV were used to define the reflected secondary gamma-ray energy distribution. The neutron and secondary gamma-ray double-differential current albedos were converted to number albedos, differential current- and flux-dose albedos, and current- and flux-dose albedos. These data are compared with albedo data reported by other investigators for iron slabs and concrete slabs. (auth) (USGRDR)

28381 (AD–697909) DIFFERENTIAL NEUTRON AND SECONDARY GAMMA-RAY ALBEDOS FOR STEEL-COVERED CONCRETE SLABS. VOLUME II. NEUTRON DOUBLY DIFFERENTIAL ALBEDOS FOR INCIDENT POLAR ANGLE OF 15.78 DEGREES. Wells, M. B.; Marshall, J. D. (Radiation Research Associates, Inc., Fort Worth, Tex.). 10 Jul 1969. 90p. (RRA-T–97-2). CFSTI.

This 7-volume series presents calculated neutron and secondary gamma-ray albedo data for concrete slabs covered with a 1-in.-thick steel liner. The albedo calculations were performed with a special version of the two-dimensional S_n procedure DOT. The volume presents tabulated data giving the DOT-calculated doubly differential number albedos for neutrons. Neutron albedo data are given in this volume for a polar angle of incidence of 15.78°. (USGRDR)

28382 (AD–697910) DIFFERENTIAL NEUTRON AND SECONDARY GAMMA-RAY ALBEDOS FOR STEEL-COVERED CONCRETE SLABS. VOLUME III. NEUTRON DOUBLY DIFFERENTIAL ALBEDOS FOR INCIDENT POLAR ANGLE OF 32.98 DEGREES. Wells, M. B.; Marshall, J. D. (Radiation Research Associates, Inc., Fort Worth, Tex.). 10 Jul 1969. 86p. (RRA-T–97-3). CFSTI.

28383 (AD–697911) DIFFERENTIAL NEUTRON AND SECONDARY GAMMA-RAY ALBEDOS FOR STEEL-COVERED CONCRETE SLABS. VOLUME IV. NEUTRON DOUBLY DIFFERENTIAL ALBEDOS FOR INCIDENT POLAR ANGLE OF 46.06 DEGREES. Wells, M. B.; Marshall, J. D. (Radiation Research Associates, Inc., Fort Worth, Tex.). 10 Jul 1969. 88p. (RRA-T–97-4). CFSTI.

28384 (AD–697912) DIFFERENTIAL NEUTRON AND SECONDARY GAMMA-RAY ALBEDOS FOR STEEL-COVERED CONCRETE SLABS. VOLUME V. NEUTRON DOUBLY DIFFERENTIAL ALBEDOS FOR INCIDENT POLAR ANGLE OF 59.39 DEGREES. Wells, M. B.; Marshall, J. D. (Radiation Research Associates, Inc., Fort Worth, Tex.). 10 Jul 1969. 87p. (RRA-T–97-5). CFSTI.

28385 (AD–697913) DIFFERENTIAL NEUTRON AND SECONDARY GAMMA-RAY ALBEDOS FOR STEEL-COVERED CONCRETE SLABS. VOLUME VI. NEUTRON DOUBLY DIFFERENTIAL ALBEDOS FOR INCIDENT POLAR ANGLE OF 78.9 DEGREES. Wells, M. B.; Marshall, J. D. (Radiation Research Associates, Inc., Fort Worth, Tex.). 10 Jul 1969. 88p. (RRA-T–97-6). CFSTI.

28386 (AD–697914) DIFFERENTIAL NEUTRON AND SECONDARY GAMMA-RAY ALBEDOS FOR STEEL-COVERED CONCRETE SLABS. VOLUME VII. SECONDARY GAMMA-RAY DIFFERENTIAL NUMBER ALBEDOS DATA. Wells, M. B.; Marshall, J. D. (Radiation Research Associates, Inc., Fort Worth, Tex.). 10 Jul 1969. 141p. (RRA-T–97-7). CFSTI.

28387 (AD–698580) COMPARISON OF UNCOLLIDED PORTION OF GAMMA RADIATION PENETRATING RIBBED AND PLANE SLABS. Final Report. Dubois, Gaston; Morris, Edgar E. (Illinois Univ., Urbana). Aug 1969. Contract DAHC20-70-C-0201. 72p. (NRSS–12). CFSTI.

Exposure ratios and average exposure ratios that compare the penetration of uncollided gamma radiation through ribbed and plane concrete slabs of infinite lateral extent are reported. The mass thicknesses of the plane slabs are assumed to be equal to the average mass thicknesses of the ribbed slabs. Formulas are developed for broad, monodirectional, monoenergetic sources and data are tabulated for 1.25-MeV, "fan" and plane isotropic sources. Parameters are also presented for an empirical formula that approximates the average exposure ratio for "fan" and plane isotropic sources. (auth) (USGRDR)

28388 (AD–699384) RIBBED SLAB PENETRATION: A SUMMARY REPORT. Final Report. Report on Nuclear Radiation Shielding Studies. Chilton, A. B. (Illinois Univ., Urbana). Oct 1969. Contract DAHC20-70-C-0201. 43p. (NRSS–13). CFSTI.

Work done on the comparison of 1.25-MeV gamma radiation penetration of ribbed slabs with the equivalent smeared-out slabs is summarized. It is shown how to calculate the average, maximum, and minimum ratios, using empirical formulas and constants, for a wide range of geometric parameters and for four basic source types: plane isotropic, "fan," broad beam normally incident, and broad beam incident at 60° from normal. Comparisons with experiment are indicated. The results are applied to several questions, and general criteria are given for which the smeared slab approximation may be expected to be valid. (auth) (USGRDR)

28389 (AD–699945) AUTOMATIC COMPUTATION OF IMPORTANCE SAMPLING FUNCTIONS FOR MONTE CARLO TRANSPORT CODES. PHASE I. Final Report. Eriksson, B.; Hui, S.; Kalos, M. H.; Spielberg, D.; Steinberg, H. (Mathematical Applications Group, Inc., White Plains, N. Y.). Jan 1970. Contract DASA01-69-C-0084. 55p. (MR–6909; DASA–2384). CFSTI.

Methods for the automatic generation of importance sampling functions for three-dimensional Monte Carlo radiation transport codes were developed, based on fast computation of approximate solutions of the adjoint transport equation. Computer implementation was carried out for the one-dimensional case. (auth) (USGRDR)

28390 (AD–700920) ANTE 2: A FORTRAN COMPUTER CODE FOR THE SOLUTION OF THE ADJOINT NEUTRON TRANSPORT EQUATION BY THE MONTE CARLO TECHNIQUE. Final Report. Cohen, M. O. (Mathematical Applications Group, Inc., White Plains, N. Y.). Jan 1970. Contract DASA01-68-C-0115. 160p. (MR–6910; DASA–2396). CFSTI.

ANTE 2 is a FORTRAN code designed to solve the time-dependent neutron transport equation in a three-dimensional geometry by the adjoint Monte Carlo technique. In addition to theoretical discussions, a complete description of computer input and output is presented. Also provided is a description of two test problems and comparison with the results of other codes. ANTE 2 is written in FORTRAN IV and is presently operational on a CDC-6600 digital computer. (auth) (USGRDR)

28391 (AD–701066) EXPERIMENTAL TESTS OF SHIELDING CODES. Technical Report, October 1968–August 1969. Profio, A. E. (Gulf General Atomic, Inc., San Diego, Calif.). Dec 1969. Contract F19601-69-C-0017. 215p. (AFWL-TR–69-116). CFSTI.

This is a final report on a five-year program designed to test computational procedures in reactor shielding against experimental procedures. Experimental studies included fast neutron penetration in one-dimensional and two-dimensional CH_2 shields, neutron spectrum measurements in a spherical shield of lithium hydride, and finally, neutron and secondary gamma production in a W–LiH shield. Calculations were made using one- and two-dimensional discrete ordinates and Monte Carlo methods. The measurements and calculations are compared and summarized in detail in order to assess the accuracy of the approximations used in the calculations. (auth) (USGRDR)

28392 (AD–702128) TRANSLATION TO ENDF/B AND "PHYSICS" CHECKING OF CROSS SECTIONS FOR SHIELDING. Dudziak, Donald J. (Virginia Univ., Charlottesville. Research

Labs. for the Engineering Sciences). Nov 1969. Contract DASA01-69-C-0029. 108p. (NE-3383-104-69-U; DASA-2379). CFSTI.

Evaluations of neutron interaction and photon production cross sections for sodium, magnesium, chlorine, potassium, and calcium were translated from a modified-UK format into ENDF/B format. The data were reviewed and revised to a minor extent, and can be used by the LAPH code to generate multigroup photon production cross section matrices. Several "physics" checks are proposed for the photon data, and a FORTRAN IV code, PHOX, was written to incorporate some of these checks. (USGRDR)

28393 (CERN-Trans-69-21) RECOMMENDATIONS FOR ELECTROMAGNETIC SHIELDING OF PREMISES. (Soviet Recommendations). Chekhovich, V. V.; Polonskii, N. B. Translated by A. Golovanoff (CERN, Geneva, Switzerland), from Russian. 147p. (In French). Dep. CFSTI (U. S. Sales Only).

Shielded premises and rooms have a large utilization in industry, scientific institutes, medical centers, etc. In the majority of these cases, the premises and rooms are developed by the institute itself, as at the present there is no unified project of recommendations and constructions of element types. The present recommendation has the purpose of contributing a technical aid in the choice, selection, and mounting of shielded premises and rooms, designed to give a shielding efficiency of the order of 80 to 100 db and 40 to 60 db in the frequency range from 0.15 to 1000 MHz and a shielding efficiency of 80 to 100 db in the range from 0.15 to 150 MHz. Questions on the application of shielded premises and rooms, their construction, the filtering of the electric net, and the report of methods of verification of the shielding efficiency of the premises and of the filter parameters are given. A group of contractors have participated in the development of the elements of shielded premises and rooms. The principal elements described in their recommendations are used in practice and have been tested for their flexibility and ease of use. (tr-auth)

28394 (N-70-12024) STUDY OF RADIATION HAZARDS TO MAN ON EXTENDED NEAR EARTH MISSIONS. Curtis, S. B.; Doherty, W. R.; Wilkinson, M. C. (Boeing Co., Seattle, Wash.). Dec 1969. Contract NASw-1362. 66p. (NASA-CR-1469; D-2-114299-1). CFSTI.

The particle types and energies important in the evaluation of the radiation hazard on long manned missions inside the Earth's magnetosphere are identified. Spectra of the trapped protons and electrons encountered at synchronous altitude and in a 260 nautical mile, 50° inclination circular orbit are presented, along with estimates of the uncertainties. These spectra are used to determine depth-dose curves behind typical aluminum shielding. Recent high-energy data were used to evaluate the importance of the high-energy (400 to 2000 MeV) protons in the galactic and solar cosmic-ray spectra in producing dose. The secondary dose components from 300-MeV/nucleon neon ions in water were estimated using cosmic-ray emulsion data. (auth) (STAR)

28395 (N-70-15058) ELECTRON BREMSSTRAHLUNG SHIELDING AT SYNCHRONOUS ALTITUDE BY ELECTRON TRAPPING IN DIELECTRICS. Hollis, D. L. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). 22 Aug 1969. 22p. (NASA-TM-X-53954). CFSTI.

Synchronous-altitude electron bremsstrahlung shielding by electron trapping in a layer of dielectric material on the outer surface of a spacecraft is studied. Traps in the insulating material retain bombarding electrons and produce an internal space-charge field of large magnitude. The electric field repels or slows additional electrons. This acts to reduce bremsstrahlung production, lower the photon energy, and enhance photon absorption. The breakdown phenomenon causes the shielding effect of the trapped electrons to be cyclic. Qualitative calculations indicate that a 40% decrease in mass results when a thin layer of polyethylene instead of lead is used in reducing bremsstrahlung in an aluminum wall to the same level. Suggestions are given to modify existing Monte Carlo codes for this particular application. (auth) (STAR)

28396 (N-70-20619) MONTE CARLO CALCULATIONS OF A HEMISPHERICAL DUCT NEUTRON STREAMING EXPERIMENT. Clemons, Lester Jr.; Wrights, Gilbert N.; Shook, Donald F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Mar 1970. 14p. (NASA-TM-X-1971; E-4926). CFSTI.

Two hemispherical-shell-duct neutron-streaming experiments were set up in a water tank. Each duct consisted of the air space between two concentric Plexiglas hemispheres of different radii surrounded by water. The ducts were 12.2 and 7.0 cm wide with duct centerline radii of 35.0 and 45.1 cm, respectively. PuBe neutron sources were located in each duct. A 5.10- by 4.65-cm-diameter NE-213 scintillator was used to measure the neutron fluxes at the duct mouth for the ducts empty and flooded with water. Monte Carlo calculations of the fluxes were compared with measurements. Agreement was good for the ducts empty and fair for the ducts flooded. (auth) (STAR)

28397 (NUS-665) COMPREHENSIVE EXPERIMENTAL DIFFERENTIAL NUMBER, ENERGY, AND DOSE ALBEDOS FOR SEMI-INFINITE MEDIA, FOR NORMALLY-INCIDENT GAMMA PHOTONS. Steyn, J. J. (NUS Corp., Rockville, Md.); Andrews, D. G. (Toronto Univ. (Ontario)). Mar 1970. 100p.

Differential angular and energy distributions of backscattered gamma rays were measured for photons normally incident on essentially semi-infinite scattering media of various atomic numbers. The measurements were made by permitting a highly collimated 3- × 3-in. NaI(Tl) scintillation crystal to view a sample area at the center of a scattering slab region irradiated by a broad beam of gamma radiation. The spectra were multichannel-analyzer recorded and digital-computer reduced to detector incident photon distributions. The results are expressed as plots and tabulations of measured spectra, number, energy and exposure distributions, and albedos; the albedos are fitted to simple empirical expressions. In the case of high-atomic-number scatterers, K x-ray fluorescence is separately evaluated. (auth)

28398 (ORNL-TM-2890) GENERAL METHOD OF IMPORTANCE SAMPLING THE ANGLE OF SCATTERING IN MONTE CARLO CALCULATIONS. Burgart, C. E.; Stevens, P. N. (Oak Ridge National Lab., Tenn.). 3 Mar 1970. Contract W-7405-eng-26. 51p. Dep. CFSTI.

The application of the Monte Carlo method to the solution of deep-penetration radiation transport problems requires the use of "importance sampling." A systematic approach to obtaining an importance function is to calculate the solution of the inhomogeneous adjoint transport equation (using the Monte Carlo estimator of the answer of interest as the source term) and to use this adjoint flux (or value function) as the importance function. The adjoint flux is calculated for simplified geometries using one-dimensional discrete ordinates methods. In three-dimensional deep-penetration Monte Carlo calculations the alteration of both the transport and the collision kernel is desirable. The exponential transform is quite useful for altering the transport kernel. However, selection from the altered collision kernel is much more difficult. The approach taken here is to introduce an angular grid with thirty discrete directions fixed in the laboratory coordinate system, along which particles are required to travel. After determining appropriate scattering probabilities and values of the importance function for each of the discrete directions, the selection of the outgoing direction and, hence, energy from the resulting discrete distribution is easily performed. The effects of the discrete angular grid and the capability of angular-biased Monte Carlo were investigated for neutron transport by comparison with standard Monte Carlo and discrete ordinates calculations, experiment, and exact analytic solutions for several configurations. In all cases the discrete grid alone (no angular biasing) was observed to have no significant effect on the results. Monte Carlo calculations were performed utilizing the exponential transform, non-leakage, source energy biasing, Russian roulette, and splitting plus the angular biasing. The results of these calculations illustrate the general usefulness of this discrete grid approach to angular biasing in several ways. First, meaningful results were obtained with angular biasing at much greater distances from the source than were practically possible with the earlier biasing techniques. The answers, variances, and computer times were all on the same order or better than those obtained with the earlier biasing techniques. Finally, this method utilizing the discrete grid to incorporate angular biasing requires very little human interaction once the adjoint configuration is selected. (auth)

28399 (ORNL-tr-1818) GAMMA-RADIATION SHIELDING WITH ORDINARY CONCRETE. Krueger, F. W. Translated for Oak Ridge National Lab., Tenn., from Kernenergie, 11: 197-203(1968). 11p. Dep. CFSTI.

The chemical composition of ordinary concrete can vary considerably. The influence of such variations on the attenuation of gamma radiation is investigated. It is shown that the varying composition has a negligible influence on the effectiveness of the shield. In the design of shieldings with ordinary concrete one may, therefore, neglect the specific chemical composition and calculate with an average attenuation function. This function is given; it is used to calculate tables for the attenuation of gamma radiation by ordinary concrete. (tr-auth)

28400 (SC-RR-70-98) USE OF SOLUTIONS TO THE ADJOINT TRANSPORT EQUATION FOR THE EVALUATION OF

RADIATION SHIELD DESIGNS. Renken, James H. (Sandia Labs., Albuquerque, N. Mex.). Jan 1970. 26p. Dep. CFSTI.

Expressions for calculating radiation shield performance characteristics such as photon energy deposition inside the slab and the transmitted energy current are formulated in such a way that solutions to the adjoint transport can be used to advantage. A derivation is presented which shows how the adjoint solutions are related to the desired results. Finally, a sample problem is solved, and the results of real and adjoint transport calculations are compared. (auth)

28401 A STUDY OF ^{60}Co GAMMA RADIATION TRANSPORT BY MEANS OF THE MONTE CARLO METHOD. Nydegger, Raymond Russell. Lawrence, Kan.; Univ. of Kansas (1969). 212p.

Thesis.

A Monte Carlo computer program was written to calculate the amount of γ radiation that would be transported in a wall or floor of one material such as concrete and around or beneath a wall of another material such as lead. No limitation was placed on the composition of either wall or floor. Verification of the validity of the computer program and the Monte Carlo method was accomplished by experimentally measuring the exposure transported beneath a lead wall recessed into a concrete floor. Measurements were performed using a ^{60}Co source for three geometrical configurations of wall and floor. Data for 1.25 MeV incident photons were generated using the computer program for twenty-four different combinations of beam incidence (incident azimuthal angle = 0°, incident polar angle = 45° and 60°), lead wall thickness (1.27, 2.54, and 5.08 cm), and depth of recession of the lead wall (0.0, 4.445, 8.890, and 13.335 cm) into a concrete floor (thickness = 17.78 cm). The experimental measurements verified the validity of the computer program and the Monte Carlo method. Spectra of the photon density and fluence, energy density, and fluence, and exposure as a function of photon energy were obtained by the Monte Carlo calculations. It was shown that: (1) the radiation field (photon density) beyond the lead wall is composed primarily of lower energy (approximately 100-keV) photons, (2) higher-energy photons contribute more significantly to the photon fluence than to the photon density apparently because their direction is more oblique to the floor surface, (3) intermediate-energy photons (approximately 300 keV) contribute the most to the energy density, (4) all energies of photons contribute equally to the energy fluence and exposure, and (5) the spectra are relatively invariant with lead wall thickness and depth of penetration. (TSS) (Diss. Abstr.)

28402 ATTENUATION OF LOW-ENERGY GAMMA RAYS IN ALLOYS. Rama Rao, J.; Parthasaradhi, K.; Rao, A. Lakshmana; Rao, P. V. Ramana (Andhra Univ., Waltair, India). Indian J. Phys.; 43: 298-9(May 1969).

A brief discussion of the attenuation of 84-, 100-, and 280-keV gamma rays in two platinum-rhodium alloys, one with 80%/20% platinum/rhodium and one with 60%/40%, is presented. The experimental total gamma ray cross sections are compared in tabular form to the calculated values based on data compiled by Plechaty, and the effective atomic numbers for total gamma ray interaction for both alloys are listed tabularly for all energies. (L.W.A.)

Solid-State Physics

Radiation Effects

Refer also to abstracts 27353, 27369, 27437, 27442, and 27485.

28403 (ORNL-TM-2706) RICE: A PROGRAM TO CALCULATE PRIMARY RECOIL ATOM SPECTRA FROM ENDF/B DATA. Jenkins, J. D. (Oak Ridge National Lab., Tenn.). 16 Feb 1970. Contract W-7405-eng-26. 38p. Dep. CFSTI.

The program, RICE, has been written to calculate the energy exchange probabilities between neutrons and primary recoil atoms in a given material. The program uses the ENDF/B neutron cross section library tapes as its source of basic neutron scattering data. It correctly incorporates information on anisotropic elastic scattering and inelastic scattering into the calculation of the energy exchange matrix. In addition, RICE will calculate damage cross sections, primary recoil atom spectra, and optimum cutoff energies for use in comparing displacement damage in different reactor neutron spectra. (auth)

28404 INFLUENCE OF PLASTIC DEFORMATION ON THE GROWTH OF F CENTRES IN HIGHLY PURE KCl CRYSTALS. Mehendru, P. C. (National Physical Lab., New Delhi). J. Phys., C (London); 3: 530-4(Mar 1970).

The effect of plastic deformation on the growth of F centers in highly pure KCl crystals was studied from the growth of the thermoluminescence peaks at 135, 190, and 270°C (for 40 deg C min^{-1} heating rate). These are associated with the first- and second-stage F centers, and with F centers due to deformation, respectively. The growths can be fitted by the equations of Mitchell, Wiegand, Smoluchowski and of Fröhlich and the values of the appropriate parameters are given and discussed. (auth) (UK)

28405 SYMMETRY PROPERTIES OF THE ND1 ABSORPTION CENTRE IN ELECTRON-IRRADIATED DIAMOND. Davies, G.; Lightowlers, E. C. (King's Coll., London). J. Phys., C (London); 3: 638-50(Mar 1970).

The ND1 centre is produced in natural and synthetic diamond by primary radiation damage, but only occurs in abundance when substantial concentrations of nitrogen are present in the lattice. The optical absorption associated with this centre consists of a sharp no-phonon line at 3.149 eV (80°K) and phonon-assisted structure at higher energies centred at about 3.4 eV. Uniaxial stress measurements on the no-phonon line are interpreted in terms of an A to T transition at a centre of T_d symmetry, and from this and other evidence the ND1 centre is tentatively identified with an interstitial nitrogen atom. Contrary to previous reports, no luminescence emission could be detected associated with the ND1 centre, suggesting that the decay of the excited state is dominated by nonradiative processes with a lifetime $\tau < 10^{-10}$ sec. (auth) (UK)

28406 LATTICE LOCATION AND DOPANT BEHAVIOR OF GROUP II AND VI ELEMENTS IMPLANTED IN SILICON. Meyer, O.; Johansson, N. G. E.; Picraux, S. T.; Mayer, J. W. (California Inst. of Tech., Pasadena). Solid State Commun.; 8: 529-31(Apr 1970).

Channeling and Hall-effect measurements indicated that implanted Se and Te ions in silicon occupied substitutional sites and exhibited donor behavior similar to that found for group V elements. Zn, Cd, and Hg were found on tetrahedral interstitial sites and weak n-type behavior was observed. (auth) (UK)

28407 EFFECTS OF LATTICE VIBRATIONS ON PROTON BLOCKING. Mueller, R. M.; White, W. (Nuclear-Chicago Corp., Des Plaines, Ill.). Phys. Lett.; 31A: 431-2(20 Apr 1970).

Proton blocking patterns for crystals of nearly identical structure, lattice parameter, and atomic number show marked differences in appearance which are ascribed to differences in vibrational amplitudes. (auth)

28408 DEFECT DECORATION AND INCREASED RADIATION RESISTANCE IN QUARTZ. Shternberg, A. A.; Gordienko, L. A.; Tsinober, L. I. (Inst. of Crystallography, Moscow). Sov. Phys.-Cryst. (Engl. Transl.); 14: 728-32(Mar-Apr 1970).

Translated from Kristallografiya; 14: 845-51(Sep-Oct 1969).

Natural and synthetic quartz crystals were treated with hydrochloric acid under hydrothermal conditions. Such crystals do not acquire smoky or citrine colors on exposure to ionizing radiation. Infrared spectra show that hydrogen ions diffuse into the quartz, the aluminum–alkali defects (potential color centers) being replaced by aluminum–hydrogen defects, which do not become color centers under irradiation. This treatment, if given in autoclaves lined with copper, causes copper decoration of the defects and also diffusion of copper into the crystal. (auth)

28409 RELAXATION PROCESSES IN IRRADIATED RUBIES. Bates, C. A.; Dixon, J. M. (Univ. of Nottingham, Eng.). J. Phys., C (London); 2: 2225-36(Dec 1969).

Using a dynamic Jahn–Teller model, it is found that the Cr^{1+} ion, produced in ruby crystals by x-irradiation, behaves as a fast relaxing impurity with a relaxation time of the order of 10^{-9} sec at very low temperatures. The problem of cross-relaxation between a Cr^{3+} ion and a Cr^{2+} ion in the presence of a magnetic field directed along the c axis is analyzed in detail by computer using a dipole–dipole interaction Hamiltonian. The associated relaxation time T_x is found to be much shorter than the usual Cr^{3+}-lattice relaxation time. T_x is found to vary with temperature T according to the relation $T_x \propto T^{-n}$ where n is approximately 3.5 in agreement with the measurements of Mason and Thorpe (1966). Possible relaxation processes in irradiated rubies are also briefly examined. (auth) (UK)

28410 TRAPPING AND THERMAL RELEASE OF NOBLE GASES AT A NICKEL SURFACE. Truhlar, John F.; Donaldson, E E.; Horne, D. E. (Washington State Univ., Pullman). J. Appl. Phys.; 41: 2139-45(Apr 1970).

The trapping and thermal remission of 100- to 300-eV Ar^+ and Kr^+ ions at a polycrystalline nickel target have been studied. For Ar^+ and Kr^+ the trapping probabilities are, respectively, 0.020 and 0.015 at 100 eV and 0.46 and 0.33 at 300 eV. A continuous temperature increase of the target releases trapped argon discontinuously by thermally activated processes at temperatures corresponding to activation energies of 1.12, 1.31, 1.48, 1.67, 1.83, and 2.13 eV. These energies are compared with activation ener-

gies determined by others for the removal of defects resulting from radiation damage or cold working of nickel. The lowest three energies are believed to be correlated, respectively, with interstitial migration, vacancy formation, and vacancy migration near the surface. The highest energy may be due to surface recrystallization from dislocations produced by the ion bombardment. The intermediate energies probably correspond to the motion of nickel surface atoms along the ridges of facets formed during the bombardment. (auth)

28411 RADIATION EFFECTS IN SOLIDS: THEORY OF SEMICONDUCTORS. Baruch, P. (Ecole Normale Superieure, Paris). pp 87-105 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

The possible interactions between a semiconducting crystal and nuclear radiations are summarized. Macroscopic and microscopic radiation effects in semiconductors are discussed. 13 refs. (D.L.C.)

28412 SOME ASPECTS OF RADIATION DAMAGE IN COVALENT CRYSTALS. Mitchell, E. W. J. (Univ. of Reading, Eng.). pp 261-321 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

A review is presented of radiation effects in covalent crystals, in which atomic displacement by nuclear encounter is the main event. Optical effects (electronic and vibrational spectra) are discussed. Examples are given using diamond, graphite, Si, Ge, and GaAs. The mechanism of annealing is discussed. 48 references. (D.L.C.)

28413 CARRIER LIFETIMES IN γ-IRRADIATED ANTHRACENE. Ringel, H. (Queens Coll., Flushing, N. Y.); Whitten, W. B.; Damask, A. C. J. Chem. Phys.; 52: 1956-9(15 Feb 1970).

The effect of ^{60}Co gamma rays on the lifetimes of photoinjected electrons and holes in anthracene has been studied. Reciprocal lifetimes of both carriers vary linearly with dose. Steady-state space-charge-limited current measurements gave a production rate for deep electron traps of 1.4×10^9 cm$^{-3} \cdot$R^{-1}. The variation of lifetime with dose is interpreted in terms of radiation-produced traps with trapping cross sections comparable to the geometric cross section of a unit cell. (auth)

28414 STUDIES ON BOMBARDMENT-INDUCED DISORDER. IV. A MODEL FOR INTERPRETING MEASUREMENTS OF THE FORMATION OF BOMBARDMENT-INDUCED DISORDER. Kelly, Roger (McMaster Univ., Hamilton, Ont.). Radiat. Eff.; 2: 281-6 (Mar 1970).

It is well established that ion bombardment of certain solids leads to the formation of a disordered, often amorphous, phase. Though it is not difficult to describe the fractional disordering (F_d) as a function of the depth and of the volume disordered per ion impact, there is still no adequate model which relates F_d to the fraction of inert gas (F_{IB}) that would be released during the thermal annealing or chemical dissolution of the disorder. It is shown that an analytically manageable relation between F_d and F_{IB} can be obtained on the basis of four assumptions, the most critical of which is that each ion impact gives rise to a compact, rather than fragmented, disordered region. This relation is shown to be reasonably well obeyed with Al_2O_3, diamond, and $ZrSiO_4$, making it possible to estimate both the effective depth of disordering (R_d) and the size of the disordered regions ($V_d^{1/3}$). R_d for 10-keV Kr bombardment is with all three substances roughly 140 Å. Likewise, $V_d^{1/3}$ is 14-20 Å with Al_2O_3, 13-16 Å with diamond, 20-27 Å with $ZrSiO_4$, and thus similar to what is observed using alternative approaches (e.g., electron microscopy) with Al_2O_3, Ge, Si, and $ZrSiO_4$. (auth)

28415 ENDOR STUDY OF THE H CENTER IN LiF. Dakss, M. L. (IBM Watson Research Center, Yorktown Heights, N. Y.); Mieher, R. L. Phys. Rev.; 187: 1053-61(15 Nov 1969).

An ENDOR study of the H center in x-irradiated LiF was performed. Hyperfine constants for 10 sets of nonequivalent neighboring nuclei were determined by fitting the data with a spin Hamiltonian. The results of this study show that the H center is an F_2^- molecule ion which is oriented along a ⟨110⟩ direction and located on an F^- lattice site, and which is associated with a Na^+ impurity. (auth)

28416 THERMAL NEUTRON-INDUCED RECOIL DEFECTS IN P-TYPE CADMIUM TELLURIDE. Barnes, C. E. (Sandia Labs., Albuquerque, N. Mex.); Kikuchi, C. Radiat. Eff.; 2: 243-8 (Mar 1970).

During thermal-neutron irradiation, Frenkel defects are produced in CdTe following radiative capture of thermal neutrons by ^{113}Cd. The resulting excited ^{114}Cd nucleus recoils out of its lattice position due to the emission of about 9 MeV of prompt gamma rays. The properties of these defects were studied by measuring the Hall effect and electrical conductivity before and after successive irradiations. The results indicate that a cadmium interstitial-associated defect may be responsible for hole removal in p-type CdTe. This defect recovers in an annealing stage centered at 130°C. (auth)

28417 THERMAL CONVERSION OF INTERSTITIALS. Simpson, H. M.; Sosin, A. (Univ of Utah, Salt Lake City). Radiat. Eff.; 2: 299-302(Mar 1970).

The dislocation pinning experiments of Thompson and colleagues in gamma-irradiated Cu and the conversion-two interstitial model of Bauer et al. are discussed. The Stage I defect is an interstitial with axis along the ⟨111⟩ direction, and the Stage III defect is visualized as the ⟨100⟩-oriented interstitial (dumbbell). The pinning experiments are analyzed with three-dimensional diffusion as the premise for both interstitials in the model. The fit to the experimental data is excellent. (D.L.C.)

28418 MINORITY CARRIER LIFETIME DEGRADATION AND ANNEAL IN NEUTRON IRRADIATED LITHIUM-DIFFUSED n-TYPE SILICON. Passenhein, B. C.; Naber, J. A. (Gulf General Atomic Inc., San Diego, Calif.). Contract NAS7-100. Radiat. Eff.; 2: 229-31(Mar 1970).

The room-temperature neutron degradations of the minority carrier lifetimes in lithium-diffused and nonlithium-diffused n-type float-zone silicon are found to be comparable. The isochronal annealing of 90 percent of the neutron damage in lithium-diffused material takes place between 300 and 380°K. The dominant contribution to this annealing is attributed to the diffusion of lithium in silicon. (auth)

28419 COMPUTER SIMULATION OF DISPLACEMENT SPIKE ANNEALING. Doran, D. G. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Radiat. Eff.; 2: 249-67(Mar 1970).

A computer simulation of short-term annealing of 5- and 20-keV displacement cascades in α-iron was carried out. A Monte Carlo technique was used to move the defects in correlated random walks on a bcc lattice. Correlations extended to 10th neighbors for interstitials and 5th neighbors for vacancies. A low-temperature simulation permitted only interstitial migration, whereas a high-temperature simulation permitted both interstitial and vacancy migration with a jump frequency ratio of 100 to 1. Temperature sensitive parameters included the jump frequency of the di-interstitial relative to the single interstitial and the recombination region for unlike defects. Annihilation amounted to 80 percent and 50 percent at high and low temperature, respectively. Relative to the low-temperature anneal, the high-temperature anneal resulted in about the same number of vacancy clusters (although the production of large clusters was clearly enhanced) and only one-third as many interstitial clusters. A detailed description of intermediate and final cluster size distributions is presented. (auth)

28420 DEVIATIONS FROM MATTHIESSEN'S RULE AND LONGITUDINAL MAGNETORESISTANCE IN COLD-WORKED AND NEUTRON-IRRADIATED COPPER. Lengeler, B.; Schilling, W.; Wenzl, H. (Kernforschungsanlage, Juelich, Ger.). J. Low Temp. Phys.; 2: 237-54(Mar 1970).

Deviations from Matthiessen's rule (MR) in cold-worked Cu samples have been measured as a function of temperature between 4°K and room temperature. They can amount up to 100% of the residual resistivity. A second group of measurements concerns deviation from the additivity of the residual resistivities that arise in the deformed specimens when point defects are added at 4.6°K during a neutron irradiation. In a third group of experiments, deviations from MR were investigated as a function of temperature in undeformed Cu samples that have been neutron irradiated at 4.6°K and annealed at different temperatures. There are two essential reasons for these deviations: (1) Defects can change the vibrational behavior of the lattice and so alter the temperature-dependent part of the electrical resistivity. The additional resistivity is found experimentally and theoretically to depend as T^5 on temperature at low temperatures. (2) Anisotropies in the Fermi surface of Cu and in the scattering potentials of the defects give rise to deviations from MR. These deviations can be described by a two-band model for the conduction electrons. Within the framework of this model, the deviations that were measured in the deformed Cu samples and in Cu alloys (earlier experiments) were described in a consistent way, using the same parameters (ratio τ_N/τ_B of the relaxation times for the neck and belly of the Fermi surface) for the two-band model. Furthermore, it could

be shown that the enhanced resistivity increase during neutron irradiation observed in deformed Cu samples is not the consequence of an enhanced defect production rate but is a result of deviations from MR due to the different scattering behavior of the defects induced by irradiation and cold work. Measurements of the longitudinal magnetoresistance of the deformed and irradiated copper samples give additional information about the scattering anisotropy of the defects and therefore allow the separation of the contributions of the two types of defects whose combination causes deviations from MR. (auth)

28421 SIMPLE METHOD OF OBSERVING AXIAL AND INTERPLANAR CHANNELING. Skvortsov, V. V.; Bogdanovskaya, I. P. (Tashkent State Univ.). JETP Lett. (USSR)(Engl. Transl.); 11: 1-3(5 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu; 11: 3-7(5 Jan 1970).

A method for studying channeling in crystals is described that does not require an accelerator. A point-like radioactive source, consisting of a Pt wire coated on its spherical end with ^{210}Po, is positioned near the crystal, and a photographic plate on the other side of the crystal records the channeled alpha particles. The exposure time is very long (14 to 36 hr), but this method has advantages. Results obtained on Si single crystals are described. (D.L.C.)

28422 ENHANCED OUTDIFFUSION IN ION-IMPLANTED SILICON. Meyer, O.; Mayer, J. W. (California Inst. of Tech., Pasadena). Phys. Lett.; 31A: 387-8(6 Apr 1970).

The distribution of ions implanted in Si at 50 to 400 keV was found to shift preferentially towards the surface during thermal anneal sequences. This suggests that outdiffusion studies as gas release may not represent bulk-diffusion properties in crystals. (auth)

28423 MOESSBAUER-EFFECT STUDY OF PARAMAGNETIC RELAXATION OF Er IMPURITIES IN Zr. Hirst, L. L. (Technische Hochschule, Munich). J. Phys. Chem. Solids; 31: 655-67(Apr 1970).

Moessbauer emission spectra of dilute Er impurities in Zr, in the paramagnetic state with zero external field, were measured at various temperatures from 4.2 to 35°K. At the lowest temperatures, due to the slow relaxation of the electronic moment, a splitting into five lines is seen, which transforms into a single-line pattern by about 35°K as the relaxation rates increase. To quantitatively interpret these spectra it is necessary to treat the coupled system of paramagnetic moment plus nuclear spin as the basic resonant system, where the off-diagonal elements of the hyperfine coupling must be included. Such a theory was worked out and yields a good fit to the data over the entire temperature range. The paramagnetic relaxation information determined from such a fit is the same as could in principle be obtained from paramagnetic resonance, but the Moessbauer-effect measurements are more sensitive and are feasible at much higher temperatures. At low temperatures the relaxation is dominated by an exchange coupling, J_{s-f}, to the conduction-electron spins. The product $|J_{s-f}N_E|$, where N_E is the density of states, is determined to be 0.034. At higher temperatures ($\gtrsim$ 20°K) evidence is seen for relaxation processes proceeding via higher crystal-field levels. (auth) (UK)

28424 ONE-PHONON ABSORPTION FROM ALUMINIUM COMPLEXES IN SILICON COMPENSATED BY LITHIUM OR ELECTRON IRRADIATION. Devine, S. D.; Newman, R. C. (J. J. Thomson Physical Lab., Reading, Eng.). J. Phys. Chem. Solids; 31: 685-700(Apr 1970).

Silicon containing 10^{19} atom cm^{-3} of aluminium was compensated by (a) lithium diffusion and (b) irradiation by 1.5-MeV electrons. The one-phonon band mode absorption was measured in both types of sample that contain $Al^-(s)-Li^+(i)$ and $Al^-(s)-Al^{2+}(i)$ pair defects respectively; the latter center was identified by EPR measurements. In the lithium-compensated sample, in-band resonances were observed at 520 cm^{-1} due to Li and at 469 cm^{-1} and 431 cm^{-1} due to the paired $Al^-(s)$. A resonant mode at 242 cm^{-1} was ascribed to the vibrations of $Al^{2+}(i)$ in the irradiated sample and this is compared in detail with the similar lithium mode. This sample also showed marked absorption features characteristic of the critical point structure of the silicon density of states. These measurements are compared with neutron scattering data and previously measured one-phonon absorption. The initial removal rate of $Al^-(s)$ by the irradiation as determined from resistivity measurements had the very high value of 2 atom per electron-cm. Interesting surface effects were also observed in these measurements and related to the diffusion of defects; the activation energy of diffusion of $Al^{2+}(i)$ has been estimated to be about 1.2 eV. These results give further information about the products of the electron irradiation damage process, and also about the one-phonon absorption associated with vacancy and interstitial impurity complexes. (auth) (UK)

28425 ELECTRON IRRADIATION DAMAGE IN SILICON CONTAINING CARBON AND OXYGEN. Bean, A. R.; Newman, R. C.; Smith, R. S. (J. J. Thomson Physical Lab., Reading, Eng.). J. Phys. Chem. Solids; 31: 739-51(Apr 1970).

Infrared absorption bands were measured in the range 1 to 25 μm for a large number of silicon samples containing oxygen and carbon impurities after various doses of irradiation at room temperature by 2-MeV electrons. Measurements were made of the removal rates of oxygen and carbon from normal unperturbed interstitial and substitutional sites, respectively, and similar results are presented for the growth of the A-center and divacancy bands. The presence of oxygen increases the carbon removal rate as defined above and likewise the presence of carbon increases the removal rate for oxygen and leads to a large increase in the rate of formation of divacancies. It is concluded that carbon traps interstitial silicon atoms and is then itself ejected into interstitial sites in the manner previously found for group III impurities. The interstitial carbon appears to be mobile at room temperature and a large number of new vibrational bands were observed. Several new bands thought to be of electronic origin and involving carbon atoms were also detected. (auth) (UK)

28426 DEFECTS IN CRYSTALLINE QUARTZ: ELECTRON PARAMAGNETIC RESONANCE OF E' VACANCY CENTERS ASSOCIATED WITH GERMANIUM IMPURITIES. Feigl, F. J. (Lehigh Univ., Bethlehem, Pa.); Anderson, J. H. J. Phys. Chem. Solids; 31: 575-96(Apr 1970).

Magnetic resonance measurements on crystalline quartz doped with germanium indicate E_1' and E_2' trapped electron centers can be produced by low-energy ionizing radiation (50-kVp x rays). Most of these vacancy-related centers are associated with substitutional Ge impurities rather than Si host cations. Analyses of detailed spectroscopic data in terms of nonbonding s−p hybrid orbitals formed from atomic Si or Ge orbitals, as appropriate, effectively account for the basic paramagnetic responses. Two distinct but quite similar EPR spectra of the E_1'-type associated with Ge impurities are observed, each characteristic of a specific treatment (x irradiation and heating). A single-oxygen-vacancy E-defect model for E' center geometry is proposed. The model is based on the spectroscopic data and experimental results on generation and bleaching of paramagnetic vacancy centers in α-SiO_2: Ge. The various E_1' and E_2'-type magnetic centers are pictured as modifications of this basic E defect. These result from interposition of common impurities (hydrogen in particular) and trapping of electrons or holes. (auth) (UK)

28427 ANNEALING OF LIFETIME DAMAGE IN NEUTRON-IRRADIATED SILICON. Kawamoto, H.; Oldham, W. G. (Univ. of California, Berkeley). Appl. Phys. Lett.; 16: 346-8(1 May 1970).

A gated p−n junction diode was used to study the effects of neutron damage on the various lifetime parameters in silicon. Isochronal annealing of heavily irradiated devices leads to the observation of two annealing stages: one in the range 150 to 250°C corresponding to the previously reported divacancy anneal, and the other in the range 300 to 400°C corresponding to the anneal of oxygen-associated defects. The diffusion current, the space-charge generation current, and the space-charge recombination current show similar annealing behavior, suggesting that the damage complexes in the space-charge region are essentially of the same nature as those in the neutral bulk region. (auth)

28428 RADIATION EFFECTS AND OXYGEN VACANCIES IN SILICATES. Chatelain, A.; Kolopus, J. L.; Weeks, R. A. (Oak Ridge National Lab., Tenn.). Science; 168: 570-1(1 May 1970).

Proton and electron irradiation of silicates, minerals, and rocks produces a paramagnetic defect whose resonance spectrum is identical to that of the singly charged oxygen vacancy in silica glass and α-quartz. It is suggested that this defect is characteristic of all structures containing SiO_4 tetrahedra. Cracks, fracturing, and electric discharges were observed after irradiation in planes determined by the particle ranges. These processes may contribute to the erosion and transport of lunar surface materials. (auth)

28429 IMPLANTATION OF ALUMINUM AND ANTIMONY INTO SILICON TARGETS BY ARGON ION BOMBARDMENT. Shimizu, Keizo (Electrotechnical Lab., Tokyo); Kawakatsu, Hisazo; Ishikawa, Yoshimitsu; Kanaya, Koichi. Denki Shikensho Iho; 33: 1383-91(1969).

Argon−ion bombardment (20 to 50 keV) induced-type conversion

and junction formation in silicon, on which a dopant layer (Al or Sb, 100 to 1,000 Å) is deposited, were studied. This method is based on a billiard-ball model. Some characteristic properties of the method and experimental results are discussed compared with that of usual ion implantation. The impurity gradient at the junction estimated from the relationship of capacitance to reverse voltage is not abrupt. The junction depth is obtained to be less than 1 micron by the experiment. This is a kind of ion-implantation technique, but the ionization of the dopant is not necessary. (auth)

28430 PHOTON–ELECTRON TRANSFORMATIONS IN SUBSTANCES DURING PASSAGE OF BREMSSTRAHLUNG RADIATION AND ITS PRACTICAL APPLICATION. Gelashvili, Sh. Sh.; Vorob'ev, V. A. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR; 57: 309-12(Feb 1970). (In Russian).

Transformation of γ radiation in the energy range of 10 to 30 MeV during its passage through thin crystals of KCl, KBr, and KI was studied. The transition curves (relative intensity as a function of crystal thickness and radiation energy) are also considered. Blackening of a roentgen plate was found to be inversely proportional to the thickness of the crystal placed in front of it. The dependence of the plate blackening on the crystal density was established. (auth)

28431 CONVERSION OF AN n-TYPE INTO A p-TYPE SEMICONDUCTOR BY ELECTRON IRRADIATION OF GALLIUM ANTIMONIDE DOPED WITH TELLURIUM: STUDY BY THERMAL CONDUCTIVITY. Poujad, Anne-Marie (Commissariat a l'Energie Atomique, Saclay, France); Albany, Halim Joseph. Compt. Rend., Ser. B; 270: 840-3(1 Apr 1970). (In French).

The variation of the thermal conductivity with the integrated electron flux at low temperature, in the region of the conversion of n-type into p-type, underlines the influence of both the energy levels introduced and their charge state on the electron–phonon type diffusion. (France)

28432 DIFFUSION OF KRYPTON IN CESIUM AND RUBIDIUM IODIDE. A COMPARISON OF RESULTS OBTAINED FOLLOWING REACTOR IRRADIATION AND ION BOMBARDMENT. Matzke, Hj.; Springer, F. (CCR–EURATOM, Ispra, Italy). Z. Naturforsch.; 25a: 252-6(Feb 1970).

The present study shows that under suitably chosen conditions, the same results of rare gas diffusion coefficients can be obtained in samples which are reactor irradiated to produce a homogeneous concentration of rare gas, and in samples that are labeled with rare gas by controlled ion bombardment. In the present study, the diffusion of krypton in RbI and CsI was found to follow the empirical rule of yielding activation enthalpies in the range $(1.4 \pm 0.2) \times 10^{-2}\ T_m$ eV, with T_m = melting point in °K. Trapping of rare gases (gas–gas or gas–damage interactions) was observed at high gas concentration. (auth)

Physical Properties

Refer also to abstracts 27729, 27781, 27789, 27818, 27834, 28080, 28152, 28198, 28460, and 28461.

28433 (ORO–3674-3) MAGNETIC PHENOMENA AT METAL SURFACES. Technical Progress Report, January 1–December 31, 1969. Spooner, Stephen (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). 23 Feb 1970. Contract AT(40-1)-3674. 36p. Dep. CFSTI.

COBALT—magnetic properties of films of, polarized neutron mirror experiments on
COMPUTERS—language for, routine coding for FOCAL
COPPER—phonon scattering measurements in crystals of
NEUTRON-DIFFRACTION ANALYSIS—control system for, computer
NEUTRON SPECTROSCOPY—computer control of experiments in (D.L.C.)

28434 STUDY OF THE DYNAMICS OF GROUP V TRANSITION-METAL HYDRIDES BY MEANS OF INELASTIC NEUTRON SCATTERING. Chernoplekov, N. A.; Zemlyanov, M. G.; Somenkov, V. A.; Chertkov, A. A. Sov. Phys.-Solid State (Engl. Transl.); 11: 2343-9(Apr 1970).

Translated from Fiz. Tverd. Tela; 11: 2894-2901(Oct 1969).

The inelastic-scattering spectra of cold neutrons were measured by the time-of-flight method for $VH_{0.86}$, $VD_{0.77}$, and $NbH_{0.95}$ samples at room temperature and, for $NbH_{0.95}$, at 200 and 250°C. The functions $\theta(\epsilon)$ were found from the experimental data, where ϵ is the change in neutron energy during scattering; these functions are the densities of vibrational states, distorted by the energy dependence of the mean square polarization vector. For $NbH_{0.95}$ at room temperature, there is a sharp boundary between the regions of acoustical and optical vibrations, a splitting of the optical band, and practically no quasielastic scattering. When the temperature is increased, quasielastic scattering appears and the optical band blurs. For $VH_{0.86}$ and $VD_{0.77}$, the acoustical and optical bands in the vibrational spectra greatly overlap, and the optical band is also split. The experimental data are compared with those for hydrides of other transition metals and vanadium and niobium hydrides of different compositions. Possible dynamical models are considered for a description of thermal-excitation spectra of hydrides of group V metals, especially in connection with the disordering in the sublattice of light atoms during temperature increases. (auth)

28435 BEHAVIOR OF EUROPIUM OXIDE. Crisan, M. (Univ., Cluj). Stud. Cercet. Fiz.; 22: 25-7(1970). (In Rumanian).

The Curie temperature for EuO is calculated using the results obtained by a Green's function method. The exchange and superexchange constants are determined for the Curie temperature $T_c = 77$°K. (auth)

28436 LATTICE DYNAMICS OF YTTRIUM AT 295 K. Sinha, S. K.; Brun, T. O.; Muhlestein, L. D.; Sakurai, J. (Ames Lab., Iowa). Phys. Rev., B; 1: 2430-41(15 Mar 1970).

Phonon-dispersion curves along the $[10\bar{1}0]$, $[11\bar{2}0]$, and [0001] symmetry directions of the hcp metal yttrium were measured by inelastic neutron scattering using the triple-axis neutron spectrometer at the Ames Laboratory Research Reactor. The dispersion curves are not strikingly different from those of other hcp metals with a similar c/a ratio. A careful search was made for Kohn-type anomalies, and evidence for two such anomalies has been obtained. A modified axially symmetric force-constant model has been used to fit the phonon frequencies, and it has been found that although forces acting normally to the basal plane are not large beyond first neighbors, forces acting parallel to the basal plane are long-ranged, and interactions up to at least sixth neighbors have to be taken into account. The fitting was done in a linear manner using Fourier analyses of the dispersion curves and other linear constraints such as the elastic constants. A frequency-distribution function was calculated and used to calculate the specific heat and anisotropic Debye–Waller factor. Good agreement was obtained on comparison with the experimental data. (auth)

28437 ENERGY BANDS FOR FCC LANTHANUM AND PRASEODYMIUM. Myron, H. W.; Liu, S. H. (Ames Lab., Iowa). Phys. Rev., B; 1: 2414-17(15 Mar 1970).

The energy bands of lanthanum and praseodymium in the face-centered-cubic structure were calculated using the relativistic augmented-plane-wave method. Calculations for the density of states, the magnetic susceptibility, and the Fermi surface are also performed, and the results are correlated with some of the electronic and magnetic properties of these metals. (auth)

28438 MAGNETOMORPHIC OSCILLATIONS IN ELECTRICAL CONDUCTIVITY OF CADMIUM CYLINDERS. Mackey, H. J.; Sybert, J. R.; Hight, R. D. (North Texas State Univ., Denton). Phys. Rev., B; 1: 2385-91(15 Mar 1970).

Magnetomorphic oscillations were observed in the Hall resistivity and magnetoresistivity of cylindrical samples of 99.9999%-grade cadmium. The magnetic field was directed along [0001], normal to the cylinder axis. The oscillations are due to the lens-shaped pocket of electrons in the third zone. No evidence of harmonics or of the contribution of the "hole arms" of the second zone was observed. The data are compared with theoretical expressions for period, phase, and dependence of amplitude on magnetic field. The period is shown to be proportional to the ratio g/d, where g is the Gaussian radius of curvature of the lens apex and d is the cylinder diameter. The amplitude is shown to damp more rapidly with magnetic field as the diameter is decreased, approaching the theoretical rate $H^{-\frac{1}{2}}$ for larger samples. Values computed for the relative phase are in disagreement with theory. (auth)

28439 INTRODUCTION TO CRYSTAL DEFECTS. Quere, Y. (CEN, Fontenay-aux-Roses, France). pp 3-42 of Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

An elementary review is presented of defects in crystals. Point defects, dislocations, surface defects, and volume defects are discussed. Some of the most important interactions between defects are described. Some defect-sensitive properties, including those resulting after irradiation, are considered. (D.L.C.)

28440 PRODUCTION AND PROPERTIES OF ELECTRON AND HOLE CENTERS IN PURE AND DOPED ALKALI HALIDE CRYSTALS. Pick, Heinz (Univ., Stuttgart). pp 193-240 of

Solid State Dosimetry. /Amelinckx, S. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

From Conference on Solid State Dosimetry, Brussels, Belgium. See CONF-670976.

After a description of the properties and defect structure of alkali metal halide crystals, the trapped electron centers, hole centers, and impurity centers are discussed. (D.L.C.)

28441 STUDIES OF THE DYNAMICAL JAHN–TELLER EFFECT ON STATIC MAGNETIC SUSCEPTIBILITY. Sasaki, Ken; Obata, Yukio (Japan Atomic Energy Research Inst., Tokai). J. Phys. Soc. Jap.; 28: 1157-67(May 1970).

Static magnetic susceptibilities of simplified model vibronic systems where non-Kramers paramagnetic ions in triplet ground state interact either with localized tetragonal modes of vibration with sharp frequency spectrum at ω (localized model), or with tetragonal modes composed of the superposition of phonons with continuous frequency spectrum (Debye model) are calculated in a rigorous way. The susceptibility is simply expressed in terms of a temperature-dependent reduction factor $\gamma_L(T)$ for the localized model, or $\gamma_D(T)$ for the Debye model, which diminishes the effective Curie constant and makes the susceptibility deviate from the Curie–Weiss law. The theory explains the characteristic features of the susceptibilities of dilute solid solutions of UO_2 in ThO_2 measured by Slowinski and Elliott and by Comly, for example, the convex curvature of reciprocal susceptibility vs temperature plot. The values of parameters determined to fit the observed susceptibilities are reasonable in orders of magnitude. (auth)

28442 MAGNETIC SUSCEPTIBILITIES OF CUBIC MIXED EUROPIUM OXIDES. Grill, A.; Schieber, M. (Hebrew Univ., Jerusalem). Phys. Rev., B; 1: 2241-2(1 Mar 1970).

The magnetic susceptibility χ of polycrystalline cubic solid solutions of Eu_2O_3 with Y_2O_3, and Gd_2O_3 have been measured. The χ of Eu^{3+} in $(Eu_xY_{1-x})_2O_3$ increases with decreasing concentration of Eu^{3+} ions, although the anisotropic exchange interaction would be expected to decrease at the same time. The χ of the smaller unit-cell compound, $(Eu_{0.1}Lu_{0.9})_2O_3$, yields an even higher value for the χ of Eu^{3+} than do the Eu–Y mixed oxides, indicating a strong dependence of the crystal-field parameters on the unit-cell dimension. In $(Eu_xGd_{1-x})_2O_3$ the χ of Eu^{3+} has the same value as in Eu_2O_3 for all values of x while the χ of Gd^{3+} is given by $\chi = C/[T + (1 - x)\theta]$. (auth)

28443 ATTEMPT TO MEASURE THE ISOTOPE EFFECT IN THE WEAK ITINERANT FERROMAGNET $ZrZn_2$. Knapp, G. S.; Corenzwit, E.; Chu, C. W. (Bell Telephone Labs, Inc., Murray Hill, N. J.). Solid State Commun.; 8: 639-41(Apr 1970).

An attempt was made to measure a ferromagnetic isotope effect in $ZrZn_2$. The effect, if it exists at all, is very small. (auth) (UK)

28444 GROWTH AND IMPERFECTIONS OF METALLIC CRYSTALS. All-Union Conference on the Growth of Metal Crystals, Kiev, June 1965. Ovsienko, D. E. (ed.). New York; Consultants Bureau (1968). 276p. (CONF-650682).

Translation of Rost i Nesovershenstva Metallicheskikh Kristallov.

Forty papers are included that present research carried out in the Soviet Union on the control of growth processes and the production of metal crystals with assigned structure and properties. The papers are grouped into three sections dealing with the mechanism and kinetics of crystal growth, crystal imperfections, and generation of crystallization centers and the effect of high cooling rates. (D.L.C.)

Moessbauer Effects and NMR

Refer also to abstracts 26943, 27397, and 28072.

28445 MAGNETICALLY INDUCED ELECTRIC FIELD GRADIENTS AND HYPERFINE FIELDS IN UFe_2, $NpFe_2$, AND $PuFe_2$. Gal, J. (Nuclear Research Center, Negev, Israel); Hadari, Z.; Bauminger, E. R.; Nowik, I.; Ofer, S.; Perkal, M. Phys. Lett.; 31A: 511-12(4 May 1970).

Moessbauer studies yield the easy magnetization directions and the hyperfine interactions in UFe_2, $NpFe_2$, and $PuFe_2$. Magnetically induced electric field gradients observed previously only in a few cubic insulators, are observed for the first time in a metallic noncubic environment. (auth)

28446 MAGNETIZATION CURVES OF $ErAl_2$ SINGLE CRYSTALS AND RECOILLESS GAMMA RESONANCE AT ^{166}Er IN $Er_{1-x}Gd_xAl_2$. Purwins, H. G. (Technische Hochschule, Munich). Phys. Lett.; 31A: 523-4(4 May 1970).

On the basis of magnetization measurements on $ErAl_2$ and hyperfine measurements in $Er_{1-x}Gd_xAl_2$, an overall crystalline field splitting of the $^4I_{15/2}$ ground state of Er^{3+} of the order of 30°K is deduced. (auth)

28447 MOESSBAUER-EFFECT STUDY OF LOCAL MOMENTS OF ERBIUM IN ZIRCONIUM. Hirst, L. L.; Seidel, E. R. (Technische Hochschule, Munich). J. Phys. Chem. Solids; 31: 857-63(Apr 1970).

By means of the Moessbauer effect, magnetic hyperfine splitting of dilute Er impurities in Zr was observed in the paramagnetic state, without applied field. From analysis of the fully resolved splitting seen at 4.2°K, the hyperfine coupling constants between the ground Kramers doublet of the electronic moment and the excited-state nuclear spin were determined. By considering symmetry-imposed limits on the possible values of the electronic g tensor, it is shown that the magnetic hyperfine coupling constant is at least 15% larger than its value for Er in insulator hosts, which enhancement is attributed to conduction-electron effects. To the best of knowledge, this is the first measurement of such a conduction-electron contribution in a non-ferromagnetic system, as well as the first observation of magnetic hyperfine splitting in the zero-field paramagnetic state of a dilute alloy. (auth) (UK)

28448 OBSERVATION OF THE SUPPRESSION OF THE INELASTIC CHANNEL OF A NUCLEAR REACTION IN RESONANT NUCLEAR SCATTERING OF GAMMA RAYS IN A PERFECT SINGLE CRYSTAL. Voitovetskii, V. K.; Korsunskii, I. L.; Novikov, A. I.; Pazhin, Yu. F. JETP Lett. (USSR) (Engl. Transl.); 11: 91-4(5 Feb 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 149-53 (5 Feb 1970).

To observe suppression of the inelastic channel under conditions where the nuclear resonant scattering is dominant over electron scattering, a Moessbauer experiment was performed with a $^{119m}SnO_2$ source and a perfect Sn single crystal containing 88% ^{119}Sn. In the resonance region, the absorption is strongly attenuated, due probably to the collective character of the nuclear excitation. The asymmetry of the absorption is due to interference between the electron and nuclear scattering. The region where the Borrmann effect applies is described. (D.L.C.)

Theoretical Physics

Refer also to abstract 28500.

28449 (AD-698149) TREATMENT OF PAIRING IN MANY-BODY SYSTEMS BY AN EQUATION-OF-MOTION METHOD. Parmenter, R. H. (Arizona Univ., Tucson. Dept. of Physics). 21 Nov 1969. Contract N00014-67-A-0209-0007. 35p. (TR-2). CFSTI.

A completely unambiguous prescription is presented for extending the equation-of-motion method, including pairing, beyond the random-phase approximation. When combined with the idea of a generalized effective field, this prescription leads to a simple, self-consistent treatment of pairing, lifetime, and renormalization effects in many-body systems. (auth) (USGRDR)

28450 (JINR–P2-4952) PERTURBATION THEORY WITH THE "CUT-OFF." Blokhintsev, D. I.; Kolerov. G. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 14p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Perturbation theory with "cutoff" is considered. An algorithm of successive approximations is constructed so that fulfillment of the macroscopic causality condition and that of the scattering S-matrix unitarity is provided. (auth)

28451 (JINR–P4-4567) THEORY OF REFLECTION OF PARTICLES ABOVE BARRIER ENERGIES. Babikov, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 9p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The problem of reflection of particles in a quasi-classical $h \to 0$ limit is considered by the phase function method for energies above the barrier. (auth)

28452 THEORETICAL STUDY OF A MULTICOMPONENT GAS BY A METHOD OF LINEARIZATION AND ANALYSIS OF THE NEW LINEAR OPERATOR INTRODUCED. Drouin, Monique (Univ., Paris). Compt. Rend., Ser. B; 270: 676-9(9 Mar 1970). (In French).

The systems of Boltzmann equations verified by the distribution functions of a multicomponent gas were studied by a linearization method. Two cases were treated. In the first one, it is possible to linearize around the Maxwell distribution corresponding to a same

average temperature; in the second one, each distribution function around a Maxwell distribution with its own temperature is linearized. In this case, the eigenfunctions or pseudo-eigenfunctions for the new type of linear operators introduced are studied. (France)

28453 TRIGONOMETRIC INTERPOLATION METHOD FOR ONE-DIMENSIONAL QUANTUM-MECHANICAL PROBLEMS. Meyer, R. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 52: 2053-9(15 Feb 1970).

A rapidly converging difference method, based on harmonic analysis, is described. It can be applied to periodic or nonperiodic bound-state problems of the general Sturm–Liouville type. Numerical examples for the Mathieu problem and for the harmonic oscillator show considerable accuracy. Advantages and disadvantages of the method are discussed in a comparison with Harris's matrix transformation technique and with direct integration methods. The set of difference equations representing a quantum-mechanical problem constitutes a symmetric matrix eigenvalue problem which is approximately equivalent to the algebraic problem obtained by using a finite trigonometric basis. Basis functions associated with the difference method are related to the Dirichlet kernel. In an approximation which corresponds to the difference method, these basis functions can be treated in a similar way as Dirac's δ function. (auth)

28454 APPLICATIONS OF S-FUNCTIONAL ANALYSIS TO CONTINUOUS GROUPS IN PHYSICS. Butler, P. H.; Wybourne, B. G. (Univ. of Canterbury, Christchurch, New Zealand). J. Phys. (Paris); 30: 795-802(Oct 1969).

S functions, as developed by Littlewood, are reviewed with the aim of simplifying the algebra of continuous groups. S-function division is defined and the theory developed to a stage where a computer program was written that performs Kronecker products, branching rules, plethysms on two variables, and inner products of the symmetric group. (auth)

28455 GENERALISATION OF THE LORENTZ TRANSFORMATION. Strnad, J. (Univ. of Ljubljana, Yugoslavia. J. Stefan Inst., Ljubljana, Yugoslavia). Nature (London); 226: 137-8(11 Apr 1970).

Reference is made to Alway (Nature 224: 155 (1969)) who proposed a transformation which should be a generalization of the Lorentz transformation in special relativity. This new transformation was derived without the usual supposition of space homogeneity. The present author discusses some consequences of the proposed transformation, quoting experiments which provide evidence against the new transformation. It is concluded that the new transformation is only of mathematical interest. (UK)

28456 VARIATIONAL PRINCIPLES FROM THE SCHWARZ INEQUALITY. Kim, Chin Hyung; Kern, C. William (Ohio State Univ., Columbus. Battelle Memorial Inst., Columbus, Ohio). J. Chem. Phys.; 52: 1920-2(15 Feb 1970).

The Schwarz inequality is used to generate variational principles for evaluating perturbation sums. By constructing two suitable kets and applying Schwarz's inequality to them, a bound results which contains an arbitrary (variational) operator. The method is illustrated with reference to a family of frequency-dependent sums for which the corresponding bound is shown to be a generalized form of Hylleraas's variation–perturbation principle. It is also pointed out that the Schwarz inequality provides bounds on simple matrix elements. (auth)

28457 SPACE-TIME SYMMETRY OF TRANSVERSE ELECTROMAGNETIC PLANE WAVES. Janner, Aloysio (Katholieke Univ., Nijmegen, Netherlands); Ascher, Edgar. Helv. Phys. Acta; 43: 296-303(15 May 1970).

A way of determining the relativistic symmetry group of an electromagnetic field tensor that admits a Fourier expansion is summarized in a set of rules where the concepts of spectrum and of spectral group are introduced. This approach is applied to the case of linearly, circularly, and elliptically polarized transverse electromagnetic (TEM) waves. The group of the symmetry translations (called primitive translations), the point group, and a set of associated nonprimitive translations are explicitly given in each of the above three cases. From these groups one easily derives the symmetry group in space and time of a TEM wave, which is a non-symmorphic subgroup of the Poincaré group, i.e., a nonsplit extension of the group of primitive translations by the point group. The limit of infinite wave length is discussed, and the results are shown to be consistent with previous one relative to the symmetry of uniform electromagnetic fields. (auth)

28458 INTERACTION OF CHARGED-PARTICLE BEAMS WITH ELECTROMAGNETIC SURFACE WAVES. Pakhomov, V. I.; Rizk, H. M. (Atomic Energy Establishment, Cairo). Plasma Phys.; 11: 715-25(Sep 1969).

This work investigates the interaction of a charged-particle beam with electromagnetic surface waves on a plane interface between vacuum and a medium characterized by an arbitrary dielectric permeability. The amplification coefficients for a monoenergetic and a hot beam are derived. A particular example is studied in which the medium is an ion semiconductor. (auth) (UK)

28459 ANALYTICALLY SOLVABLE PROBLEMS IN RADIATIVE TRANSFER. II. van Trigt, C. (Philips Research Labs., Eindhoven, Netherlands). Phys. Rev., A; 1: 1298-1314(May 1970).

In the previous paper, the Biberman–Holstein integral equation was solved for a slab and for all line shapes of interest in the limit of high optical depth. The eigenfunctions and eigenvalues obtained are used for the general calculation of the stationary number density in the excited state, when collisional excitation and deexcitation take place, when excitation takes place by absorption of external radiation, or by both combined. General expressions are given for the line shape of a spectral line emitted by an optically dense slab, showing typical broadening and self-reversal. (auth)

28460 ON THE MEANING OF GOLDSTONE'S THEOREM. Morandi, G. (Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cim.; 66B: 77-89(11 Mar 1970).

It is shown that when a continuous symmetry is broken, a polar singularity arises in the vertex part at zero total energy and momentum transfer. Such singularity has as a consequence (and is in turn entirely predictable as a consequence of) the existence of a continuous manifold of degenerate ground states, and arises from the possibility of freely "rotating" the system among such states. Whether or not it is possible to infer the existence of a bosonlike excitation with frequency $\Omega(q)$ such that $\lim_{q\to 0} \Omega(q) = 0$ depends on the range of the forces. (auth)

28461 QUANTUM-ELECTRODYNAMIC CORRECTIONS TO THE ELECTRON CHARGE VALUE IN METALS. Nordtvedt, K. Jr. (Montana State Univ., Bozeman). Phys. Rev., B; 1: 81-4 (1 Jan 1970).

The quantum-electrodynamic renormalization of the electron's charge when in a metal (Fermi gas of electrons) environment is calculated. Solid-state many-body techniques are employed rather than the usual quantum-electrodynamic approach, so that the analogy to calculating a material's dielectric constant is exhibited. In metals, the renormalized charge value is increased over the vacuum value by $\delta e/e \cong 4 \times 10^{-10}\rho$, where ρ is the metal's electron density in $e/(10^{-24}\ cm^3)$. These corrections are too small to affect the recent measurements of e/h in metals using the Josephson frequency–voltage relation for superconducting junctions, which are accurate to 10^{-6}. Experiments to be done that will compare e/h values in different metals to several orders of magnitude greater accuracy should detect the corrections to e calculated in this paper. (auth)

28462 THERMODYNAMICS AND STATISTICAL PHYSICS: A SHORT INTRODUCTION. Finkelstein, Robert J. A Series of Books in Physics. San Francisco; W. H. Freeman and Company (1969). 260p. $12.00.

This book presents the essential features of thermodynamic and statistical mechanics for first-year graduate students. After a presentation of classical thermodynamics, macroscopic properties of large systems are derived from atomic theory and thermodynamic consequences of quantum theory are discussed. Statistical theory of phase transitions is also discussed. A separate abstract was prepared for the chapter on "The Third Law and the Behavior of Matter Near Absolute Zero." (D.L.C.)

For an abstract of one chapter see: 28208.

28463 MODEL-INDEPENDENT ANALYSIS OF NONRELATIVISTIC MULTIPARTICLE REACTIONS. Warren, Russell E.; Klink, William H. (Univ. of Iowa, Iowa City). J. Math. Phys. (N. Y.); 11: 1155-64(Apr 1970).

The Clebsch–Gordan coefficients for the reduction of an n-fold tensor product of nonrelativistic free-particle states into one over-all state are calculated. The degeneracy parameters resulting from this decomposition are then cast into Galilean-invariant functions of the particle momenta. Finally, the reduction is applied to the scattering matrix for nonrelativistic reactions involving an arbitrary number of final particles. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 27470.

28464 (CERN/DD/DH-69/8) COMPUTERS AND COMPUTATION IN EXPERIMENTAL HIGH ENERGY PHYSICS. Macleod, G. R. (European Organization for Nuclear Research, Geneva (Switzerland)). Jul 1969. 55p. (CONF-690706-3). Dep. CFSTI (U. S. Sales Only).

From Conference on Computational Physics, Culham, England.

A brief survey is given of the various uses of computers and the kind of computations made in high energy physics experiments. The successive stages of experiments, from the initial design to the final analysis of data, are described with examples chosen from recently completed experiments to illustrate the varied computing techniques used. Finally, some future trends to be expected are indicated, with particular reference to their dependence on developments in computer technology. (auth)

28465 (JINR-D1-4638) SEARCH FOR NEW STABLE PARTICLES. On the Occasion of the 60th Birthday of Edoardo Amaldi. Pontecorvo, B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 13p. Dep. CFSTI (U. S. Sales Only).

A method is proposed for the search for both neutral and charged stable particles. With the use of this method the radioactivity of the new particles is studied leading to their discovery. (J.F.P.)

28466 SEARCH FOR CHARGE ⅓e AND ⅔e QUARKS IN COSMIC RADIATION NEAR SEA LEVEL. Krider, E. P.; Bowen, T.; Kalbach, R. M. (Univ. of Arizona, Tucson). Phys. Rev., D; 1: 835-40(1 Feb 1970).

A large-area (3.35 m^2) scintillation-counter telescope consisting of six scintillation counters and four wide-gap spark chambers was arranged to detect single particles with charge $\pm\frac{1}{3}e$ or $\pm\frac{2}{3}e$ which might be present in the cosmic radiation near sea level. Upper limits to the vertical intensities of such particles are 9.8×10^{-11} cm^{-2} sec^{-1} sr^{-1} for charge $\pm\frac{1}{3}e$ and 1.6×10^{-10} cm^{-2} sec^{-1} sr^{-1} for charge $\pm\frac{2}{3}e$ at a 90% confidence level. (auth)

Electromagnetic

Refer also to abstract 28701.

28467 (DESY-70/6) DETERMINATION OF STRONG INTERACTION NUCLEAR RADII. Alvensleben, H.; Becker, U.; Bertram, William K.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). Massachusetts Inst. of Tech., Cambridge). Feb 1970. 10p. Dep. CFSTI (U. S. Sales Only).

Results are presented on the determination of a set of strong interaction nuclear radii using the photoproduction of neutral rho mesons. Analysis of 10^6 events from 13 complex nuclei yields the Woods-Saxon radii $R(A) = (1.12 \pm 0.02)\,A^{\frac{1}{3}}$ fm. (auth)

28468 ENERGY DEPENDENCE OF X-RAY TRANSITION RADIATION FROM ULTRARELATIVISTIC CHARGED PARTICLES. Yuan, L. C. L. (Brookhaven National Lab., Upton, N. Y.); Wang, C. L.; Uto, H.; Pruenster, S. Phys. Lett.; 31B: 603-5(27 Apr 1970).

Measurements were made on the γ (Lorentz factor) dependence of the transition radiation intensity in the X-ray region caused by positrons with γ ranging from 1000 to 8000. The results show that the intensity of the X-ray transition radiation is linearly proportional to γ as predicted by theory. Because of such a linear dependence as well as a reasonable intensity available the X-ray transition radiation can be feasibly used for the determination of the γ value of ultrarelativistic particles. (auth)

28469 OBSERVATION OF $\rho-\omega$ INTERFERENCE IN THE PHOTOPRODUCTION OF ELECTRON-POSITRON PAIRS FROM CARBON AND A MEASUREMENT OF THE $\rho-\omega$ PHASE. Biggs, P. J.; Braden, D. W.; Clifft, R. W.; Gabathuler, E.; Kitching, P.; Rand, R. E. (Daresbury Nuclear Physics Lab., Warrington, Eng.). Phys. Rev. Lett.; 24: 1197-1201(25 May 1970).

The electron-positron mass spectrum was studied in the process $\gamma + C \rightarrow e^+ + e^- + C$ in the invariant-mass region between 675 and 850 MeV/c^2. An enhancement in the region of the ω mass due to $\rho-\omega$ interference is clearly observed, and from a fit to the data $\gamma_\rho^2/4\pi = 0.50^{+0.5}_{-0.1}$ and $\gamma_\omega^2/4\pi = 3.5 \pm 1.2$ is found. The value of the relative phase of the $\rho-\omega$ photoproduction amplitudes is found to be 100^{+30}_{-50} deg. The errors quoted are purely statistical. (auth)

28470 PION ELECTROPRODUCTION ON CARBON. Titov, Yu. I.; Stepula, E. V.; Afanas'ev, N. G.; Akhmerov, R. V.; Byvalin, S. A.; Severin, N. F.; Smelov, E. M.; Yaroshevskii, L. D.; Starikova, L. P. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh.; 15: 257-65(Feb 1970). (In Russian).

Spectra of inelastic electron scattering were measured at the initial energy of 1150 MeV in the angular range 25 to 60°. Each spectrum shows two peaks, one of which is treated as quasi-elastic scattering and the other as the pion production on the nucleons of ^{12}C. The pion electroproduction cross section may be described as a sume of cross sections for the electroproduction of free nucleons. The cross section dependence on the 3-momentum transfer in the electroproduction peak allows the main regularities to be established of the Δ_{1238} isobar electroproduction on a free proton. (auth)

28471 MEASUREMENT OF THE MAGNITUDE AND PHASE OF $\rho-\omega$ INTERFERENCE IN $\pi^+\omega^-$ PHOTOPRODUCTION FROM CARBON. Biggs, P. J.; Clifft, R. W.; Gabathuler, E.; Kitching, P.; Rand, R. E. (Daresbury Nuclear Physics Lab., Warrington, Eng.). Phys. Rev. Lett.; 24: 1201-5(25 May 1970).

The reaction $\gamma + C \rightarrow \pi^+ + \pi^- + C$ was investigated in the invariant-mass region of the ρ and ω mesons and shows distinct interference effects between the ρ and ω contributions to the cross section. The experiment was performed at a mean photon energy of 4.2 GeV with 140,000 events. A phenomenological analysis of the data yields the result $\Gamma_{\omega\to 2\pi} = 0.091^{+0.031}_{-0.022}$ MeV/c^2. The relative phase of the ρ and ω terms in the amplitude is obtained and discussed. (auth)

28472 ANALYSIS OF NEAR-THRESHOLD PHOTOPRODUCTION OF CHARGED PIONS ON THE BASIS OF DISPERSION RELATIONS. Adamovich, M. I.; Larionova, V. G.; Lebedev, A. I.; Kharlamov, S. P.; Yagudina, F. R. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 11: 657-68(Mar 1970). (In Russian).

Experimental and theoretical results of studying the photoproduction of charged pions in the near-threshold region of the photon energy are compared. The constant of the pion-nucleon interaction is found to be $f^2 = 0.083 \pm 0.004$ and the upper limit for the constant of $\gamma\pi\rho$ interaction is estimated. (auth)

28473 MULTIBODY PHOTOPRODUCTION BETWEEN 2 AND 16 GeV. Davier, M.; Derado, I.; Drickey, D.; Fries, D.; Moxley, R.; Odian, A.; Villa, F.; Yount, D. (Stanford Univ., Calif.). Phys. Rev., D; 1: 790-813(1 Feb 1970).

The SLAC 2.2-m streamer chamber was used to study photoproduction from hydrogen with a 16-GeV bremsstrahlung beam. The use of a single-hadron trigger permitted a study from 2 to 16 GeV which included photoproduction of the Δ^{++} and of the vector mesons ρ, ω, and ϕ. The sample reported here represents 87,000 pictures containing 7055 hadronic events of which about 2500 were above 5 GeV. Interesting aspects of the data are the dominance of ρ^0 production in the three-prong topology at high energies, the diffraction character of high-energy ρ^0 production, the clear indication of the transversality of the ρ^0 spin orientation, and the apparent interference between the resonant $\pi^+\pi^-$ (ρ^0) production and a nonresonant background. Tests of the vector-dominance model are described, including a comparison of total photoproduction cross sections derived from our data with those obtained elsewhere by direct measurements. (auth)

28474 SCATTERING OF HIGH-ENERGY MUONS ON ELECTRONS. Jain, P. L.; Wixon, N. J.; Phillips, D. A.; Fecteau, J. T. (State Univ. of New York, Buffalo). Phys. Rev., D; 1: 813-24 (1 Feb 1970).

The elastic muon-electron interactions of 10.1-GeV/c positive and 5.0- and 14.5-GeV/c negative muons produced at the Brookhaven alternating gradient synchrotron was studied in nuclear emulsions. Energies of knockon electrons calculated from scattering measurements were compared with those obtained from their ejection angles. Integral cross sections were compared with the Bhabha prediction for the scattering of two point fermions. Excellent agreement was found for negative and positive primary muons up to $t = 3.3 \times 10^{-3}$ $(GeV/c)^2$ and $t = 1.8 \times 10^{-3}$ $(GeV/c)^2$, respectively. The results are in contradiction to some of the

previous cosmic-ray data, which show an anomalously large cross section. (auth)

28475 WIDE-ANGLE BREMSSTRAHLUNG. Lichtenstein, C. A.; Ash, W. W.; Berkelman, K.; Hartill, D. L.; Littauer, R. M.; Siemann, R. H. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 1: 825-34(1 Feb 1970).

Earlier measurements of the cross section for wide-angle electron bremsstrahlung were extended. Besides the data for symmetric final electron and photon angles already published, results are reported for asymmetric angles. The circulating electron beam of the Cornell 10-GeV synchrotron struck a carbon target and was monitored by observing the forward bremsstrahlung beam. Wide-angle photons were counted in coincidence with the corresponding scattered electrons. The recoil momentum of the unobserved nucleus was minimized. The experimental cross sections are compared with the predictions of the Bethe–Heitler formula corrected for elastic and inelastic nuclear form factors and for virtual nuclear Compton scattering. The agreement is excellent, confirming the predictions of quantum electrodynamics for timelike electron four-momenta up to 1.2 GeV. If one assumes a deviation in the experiment/theory ratio proportional to the square of the final electron-photon invariant mass, the 95% confidence upper limit on the corresponding distance parameter is $A_{(2)}^{-1} = 5.3 \times 10^{-15}$ cm. The upper limit for a fourth-power deviation is $A_{(4)}^{-1} = 6.2 \times 10^{-15}$ cm. (auth)

Weak

Refer also to abstract 28577.

28476 (UCRL-19446) CHARGE ASYMMETRY IN THE MUONIC DECAY OF THE K_3^0. Paciotti, Michael Anthony (California Univ., Berkeley. Lawrence Radiation Lab.). Dec 1969. Contract W-7405-eng-48. 105p. Dep. CFSTI.

Thesis.

The charge asymmetry $R \equiv [\Gamma(K_L^0 \to \pi^-\mu^+\nu_\mu)]/[\Gamma(K_L^0 \to \pi^+\mu^-\bar{\nu}_\mu)]$ is measured to be $1.0098 \pm .0032$. Separation of muons from pions is achieved by passage through 230 grams/cm^2 of aluminum and 870 grams/cm^2 of lead. Positive and negative muons are spatially separated behind the pion filter by application of a magnetic field preceding the aluminum and lead absorber. Data are taken with scintillation counters, and optical thin-plate and thick-plate spark chambers are used for calibration of systematic effects. (auth)

Strong (Baryon-Induced)

Refer also to abstract 28690.

28477 (COO-1195-182) A MEASUREMENT OF THE DIFFRACTION SCATTERING OF PIONS AND PROTONS FROM COMPLEX NUCLEI USING MULTIWIRE PROPORTIONAL COUNTERS. Segler, Samuel Louis (Illinois Univ., Urbana). 1970. Contract AT(11-1)-1195. 90p. Dep. CFSTI.

Thesis.

The development and testing of multiwire proportional counters is discussed. The use of a proportional counter system in an experiment to study the diffraction scattering of protons and positive pions from various complex nuclei is considered. A good precision experiment is made considerably simpler due to the high resolution characteristic of the multiwire proportional counters. Proportional counters and the experimental motivation, arrangement of the apparatus, and the experimental measurements and conclusions are presented. The differential and total cross sections for 1 GeV/c positive pion and proton scattering from complex nuclei were measured at the Argonne ZGS. The targets used were carbon, aluminum, copper, and lead. A combination of scintillation, Cherenkov, and multiwire proportional counters was used to obtain the data. The total cross sections were calculated from the observed transmissions and are in good agreement with existing data. The differential cross sections were obtained from the proportional counter hodoscope and are the first measurements at high energy for pions. Two optical models are described and compared with the results. Radius parameters are obtained for each nucleus from the slope of the differential cross section and fit to an equation of the form $R = r_0 A^{\frac{1}{3}} + C$ where A is the atomic number. The parameter r_0 is found to be $1.12 \pm .02$ fm and c is $.61 \pm .08$ fm. (auth)

28478 (DESY-70/7) NEUTRON–NEUTRON SCATTERING LENGTH FROM A KINEMATICALLY COMPLETE EXPERIMENT ON THE REACTION n + d → n + n + p. Zeitnitz, B.; Maschuw, R.; Suhr, P. (Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Feb 1970. 32p. Dep. CFSTI (U. S. Sales Only).

The coincident neutron spectra from the reaction D(n, 2n)H at $E_n = 18.5$ MeV ($\theta_1 = 24.2^0$, $\theta_2 = 31.2^0$) have been measured with a double time-of-flight spectrometer. The data were analyzed in the Watson–Migdal approximation, using a Monte Carlo technique. The results give $a_{nn} = -16.4^{+1.5}_{-1.3}$ fm for the $^1S_0$ neutron–neutron scattering length. (auth)

28479 (JINR-P1-4985) SPECTRUM OF FAST DEUTERONS EMITTED IN THE INTERACTION OF 670-MeV PROTONS WITH CARBON NUCLEI. Azhgirei, L. S.; Krumshtein, Z. V.; Ngo K'uang Tsu; Petrukhin, V. I.; Khazins, D. M.; Tsisek, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 24p. (In Russian). (CONF-690914-7). Dep. CFSTI (U. S. Sales Only).

From 3rd International Conference on High Energy Physics and Nuclear Structure, New York.

Using the magnetic and the time-of-flight spectrometers the spectrum of deuterons emitted at an angle of 6.5° in the interaction of 670 MeV protons with carbon nuclei was measured in the momentum range from 700 up to 1700 MeV/c. A new intense channel of the deuteron production (with the pion production) was observed. (auth)

28480 (UCRL-19451) NUCLEON–NUCLEON TRIPLE-SCATTERING PARAMETERS 510-670 MeV. Surko, Pamela Hansen (California Univ., Berkeley. Lawrence Radiation Lab.). 15 Jan 1970. Contract W-7405-eng-48. 44p. Dep. CFSTI.

Thesis.

The values of the Wolfenstein depolarization parameter D are reported at 670, 600, and 520 MeV for the pp interaction, over the cm angular range 30 to 120°. The transfer depolarization parameter D^t was measured at 600 and 525 MeV in the free np system, over the range 65 to 180°cm. Five points are measured at each energy, with statistical accuracy averaging about ±0.1 for D_{pp} and ±0.3 for D_{np}^t. D^{pp} is between $\frac{1}{2}$ and 1 at forward scattering angles and drops toward zero at angles greater than 90°cm. It remains positive. D_{np}^t is small and positive at measured angles less than 90° and also at 180°. There is an indication of a possible negative value between 90 and 180°. Predictions of various phase-shift solutions are compared to the data. A polarized neutron/proton beam was produced by elastically scattering the beam of the Berkeley 184" Cyclotron off deuterium/hydrogen. The polarized beam was elastically scattered off hydrogen and the polarization of the recoil proton analyzed in a carbon-slab and magneto-strictive-wire-chamber array. (auth)

28481 BACKWARD np SCATTERING WITH A POLARIZED TARGET. Robrish, P. R. (Univ. of California, Berkeley); Chamberlain, O.; Field, R. D. Jr.; (and others). Phys. Lett.; 31B: 617-20(27 Apr 1970).

The polarization parameter P in neutron-proton elastic scattering near the backward direction was measured, using a polarized proton target. Measurements covered the range of incident neutron momenta from 1.0 to 5.5 GeV/c and of four-momentum transfer squared u from –0.005 to –0.5 $(GeV/c)^2$. (auth)

28482 HYPERFRAGMENT PRODUCTION FOLLOWING SLOW Σ^- CAPTURE IN LIQUID NEON. Bugg, W. M. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.); Condo, G. T.; Garrett, N. E.; Moulder, J. W.; Cohn, H. O.; McCulloch, R. D. Contract AT-40-1-3956. Phys. Lett.; 31B: 595-7(27 Apr 1970).

The Λ^0 trapping probability following Σ^- capture in neon was determined to be 26 ± 5%. A comparable value for K^- absorption is 12 ± 4%. These observations are in contrast to calculations that suggest that Λ^0 trapping following K^- absorption should occur more often than after Σ^- capture. They also are at variance with nuclear emulsion results. (auth)

28483 DOUBLE N–N SCATTERING ON POLARIZED PROTON TARGET. Bystricky, J.; Cech, J.; Janout, Z.; Kazarinov, Yu. M.; Lehar, F.; Parfenov, L. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Czech. J. Phys.; 20: 381-94(1970).

The triple scattering depolarization transfer parameter D_t in elastic p–p scattering was measured at an energy of 660 MeV using a polarized proton target. All measurements were carried out with the help of an optical spark chamber. The following results have been obtained: $D_t(90°) = D(90°) = 0.54 \pm 0.10$, $D_t(130°) = D(50°) = 0.72 \pm 0.11$. (auth)

28484 DETERMINATION OF NEUTRON–NEUTRON SCATTERING LENGTH FROM REACTION n + d → 2n + p. Prokof'ev, A. N.; Shklyarevskii, G. M. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 11: 567-77(Mar 1970). (In Russian).

Experimental data on the reaction n + d → 2n + p at the neutron energy 14.1 MeV are analyzed. The value of the neutron-neutron scattering length was found to be $a_{nn} = -23.2^{+1.5}_{-1.3}$ f. The known experiments on determination of a_{nn} are considered and the reasons for disagreement of their results are given. (auth)

28485 DEUTERON GENERATION ON NUCLEI BY HIGH-ENERGY PROTONS. Goryachev, Yu. M.; Kanavets, V. P.; Levintov, I. I.; Morozov, B. V.; Nikiforov, N. A.; Starostin, A. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 629-35(Mar 1970). (In Russian).

The cross sections for deuteron, proton and π^+-meson production by 6.8 GeV/c protons on Be, C, Al, Ti, Cu, Ag and Au targets were measured. The secondaries with the momentum 1.23 GeV/c were detected at an angle of 15 mrad in lab. system. The A dependence of differential generation cross section can be represented as $d^2\sigma/dpd\Omega \sim A^x$, where $x_d = 1.24 \pm 0.01$; $x_p = 0.69 \pm 0.03$; $x_{\pi+} = 0.45 \pm 0.03$. The agreement with the Butler–Pearson deuteron production mechanism can be obtained if one takes into account the absorption of deuterons and nucleons in the nucleus. (auth)

28486 FURTHER INVESTIGATIONS OF π^-, K^-, AND ANTIPROTONS PRODUCTION AT THE 70-GeV IHEP ACCELERATOR. Binon, F.; Denisov, S. P.; Dyuteil, P.; (and others). (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 11: 636-40(Mar 1970). (In Russian).

Yields of π^-, K^-, and antiprotons are measured in the middle of the momentum spectrum at energies of the protons bombarding an Al target, equal to 35, 43, 52, and 70 GeV. (auth)

28487 MEASUREMENT OF THE D-PARAMETER AT 90^0 FOR ELASTIC p–p SCATTERING NEAR 1 GeV. Grayer, G. H.; Dowell, J. D.; Adams, C. J.; Eaton, G. H.; Petmezas, G. (Univ. of Birmingham, Eng.). Lett. Nuovo Cim.; 3: 663-6(23 May 1970).

The value of the Wolfenstein triple scattering depolarization parameter was measured for proton–proton elastic interactions at 984 MeV in an angular range from 70 to 110°. This parameter was found to have a value of +0.65 with a statistical error of ±0.4 and a systematic error of ±0.4. Spark chambers were used in this study. (J.F.P.)

Strong (Meson-Induced)

Refer also to abstract 28482.

28488 (COO-1195-184) OBSERVATION OF Ξ^* RESONANCES IN 5.5 GeV/c K^-p INTERACTIONS. Schultz, P. F. (Illinois Univ., Urbana). [1969] 3p. Dep. CFSTI.

Production was observed of the following previously observed Ξ^* resonances: $\Xi^*(1530)$, $\Xi^*(1930)$ and $\Xi^*(1820)$. In addition a very narrow structure, $\Gamma < 30$ MeV, at a mass of 2295 ± 15 MeV in the $\Xi^-\pi^+\pi^-$ mass combinations was observed; the statistical significance is 3 standard deviations above background. In the data, evidence for the Ξ^- being a decay product of any Y* resonance ($Y^* \to \Xi$ or $\Xi K\pi$) or any $I = 3/2$ Ξ^* resonance is not found. (auth)

28489 (NP-18205) THE PRODUCTION OF $(\mu^+\mu^-)$ PAIRS IN HIGH-ENERGY (π^-p) REACTIONS. Weilhammer, Peter (Munich Univ. (West Germany)). Dec 1969. 130p. (In German). Dep. CFSTI (U. S. Sales Only).

Thesis.

At the CERN proton synchrotron accelerator the production of mu pairs was studied after (π^-p) interactions. The mean momentum of π mesons at the target was 11.1 GeV/c. Pair formation was determined by means of a spark chamber with 2 magnetic spectrometers and a system of scintillation counters. Recorded events were evaluated from films and fed into a computer for further analysis. Quantitative analysis was limited to the special reaction $\pi^- p \to \mu^+\mu^- n$. Cross sections for the $\mu^+\mu^-$ pair decays of rho, omega, phi, and eta were determined for the vector mesons. (H.B.G.)

28490 PRODUCTION OF Ξ^- HYPERONS IN π^-p INTERACTIONS AT 5.1 GeV/c. Budagov, Yu. A.; Vinogradov, V. B.; Volod'ko, A. G.; Dzhelepov, V. P.; Dushenko, V. F.; Kladnitskii, V. S.; Lomakin, Yu. F.; Martinska, G.; Flyagin, V. B.; Shlyapnikov, V. P. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR)(Engl. Transl.); 11: 17-19(5 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu; 11: 28-31(5 Jan 1970).

The observation of the decays of the cascade hyperon $\Xi^- \to \Lambda + \pi^-$ and a determination of its production cross section in π^-p interactions at 5.1 GeV/c in a meter propane bubble chamber are reported. Double scanning of 230,000 photographs with 93% efficiency yielded 28 events, six of which satisfied the selection criteria. A comparison of the cross section obtained ($\sigma = 2.9\mu b$) with those obtained at other energies shows a smooth increase of the cross section with energy. (L.B.S.)

28491 STUDY OF THE MASS SPECTRUM OF THE ΛK SYSTEM IN π^-p INTERACTIONS AT 4 AND 5.1 GeV/c. Budagov, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR); Vinogradov, V. B.; Volod'ko, A. G.; (and others). JETP Lett. (USSR) (Engl. Transl.); 11: 19-21(5 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu; 11: 31-5(5 Jan 1970).

The results are reported of a study of the effective mass spectrum of the ΛK system, obtained in an investigation of π^-p interactions at 4 and 5.1 GeV/c in propane bubble chambers. The anomaly observed in the ΛK effective mass spectrum can be attributed either to the decay of the isobars S_{11} (1710) and P_{12} (1750) in the $N^* \to \Lambda + K$ channel, or to the existence of a new resonance with mass near 1685 MeV/c^2. (L.B.S.)

28492 RADIATIVE CAPTURE OF NEGATIVE PIONS ON PROTONS IN THE MOMENTUM RANGE FROM 220 MeV/c TO 380 MeV/c. Favier, J. (CERN, Geneva); Alder, J. C.; Joseph, C.; Vaucher, B.; Schinzel, D.; Zupancic, C.; Bressani, T.; Chiavassa, E. Phys. Lett.; 31B: 609-12(27 Apr 1970).

Negative pion radiative capture differential cross sections at forward c.m. gamma angles (around 30°) were measured at nine different incident energies between 110 MeV and 270 MeV. Experimental results are compared with the theoretical predictions based on dispersion relations for the photoproduction process, and show excellent agreement with the preliminary data. (auth)

28493 INVESTIGATION OF TWO-PRONG π^+p INTERACTIONS AT 2.34 GeV/c. Angelov, N.; Gramenitskii, I. M.; Kanazirski, Kh.; Moiseev, A. M.; Prokesh, A.; Tikhonova, L. A.; Fenyuk, A. B.; Shafranov, M. D. (Joint inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 613-25(Mar 1970). (In Russian).

Results of analysis of 17 000 two-prong π^+p interaction events at the π^+-meson momentum 2.34 GeV/c, are presented. Production cross sections and parameters for the resonances ρ^+, N^{*++}_{1238}, N^{*++}_{1688} are obtained. The production mechanism for these resonances is investigated in some detail. The $\pi^+\pi^+$-interaction cross section is determined from the $\pi^+p \to \pi^+\pi^+n$ reaction by means of the Chew–Low method. (auth)

28494 FEATURES OF THE REACTION $\pi^+d \to \pi^+d\pi^+\pi^-$ AT 4.2 GeV/c. Eisenstein, B.; Gordon, H. (Univ. of Illinois, Urbana). Phys. Rev., D; 1: 841-6(1 Feb 1970).

Prominent features of this reaction include d* production in the $d\pi^+$ system, ρ^0 production, and a low-mass enhancement (A_1) in the $\rho^0\pi^+$ system. A model for πd scattering was found to provide an adequate description of the properties of the d*. A Reggeized pion-exchange model successfully predicts the properties of the $\rho^0\pi^+$d final state, whether or not d* formation occurs. (auth)

28495 STUDY OF Ξ^* RESONANCES IN K^-n INTERACTIONS AT 3.6 AND 3.9 GeV/c. Crennell, David J.; Karshon, Uri; Lai, Kwan Wu; O'Neall, John S.; Scarr, J. Michael; Schumann, Thomas G. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., D; 1: 847-50(1 Feb 1970).

The observation of the isospin-$1/2$ $\Xi^*(1530)$ and $\Xi^*(1830)$ resonances in K^-n interactions at 3.6 and 3.9 GeV/c is reported and results concerning the production and subsequent decay of the $\Xi^*(1830)$ into $\Xi\pi$, $\Xi\pi\pi$, and ΛK are presented. A search was also made for isospin-$3/2$ Ξ^* resonances and no strong evidence was found for the existence of such states. Upper limits on production cross sections for such a particle are presented. (auth)

28496 STUDY OF THE REACTIONS $\pi^-p \to p\pi^+\pi^-\pi^-\pi^0$ AND $\pi^-p \to n\pi^+\pi^+\pi^-\pi^-$ AT 8 GeV/c. Cason, N. M.; Andrews, J. W.; Biswas, N. N.; Groves, T. H.; Harrington, E. A.; Johnson, P. B.; Kenney, V. P.; Poirier, J. A.; Shepherd, W. D. (Univ. of Notre Dame, Ind.). Phys. Rev., D; 1: 851-67(1 Feb 1970).

The reactions $\pi^-p \to p\pi^+\pi^-\pi^-\pi^0$ and $\pi^-p \to n\pi^+\pi^+\pi^-\pi^-$ were studied at 8 GeV/c. The measured cross sections are 1.39 ± 0.09 and 0.53 ± 0.04 mb, respectively. Resonance parameters and production cross sections are presented for the following resonances produced in the experiment: ρ^0, ρ^-, ρ^+, N^{*++}, ω^0, η^0, and B^-. The final states $p\omega^0\pi^-$ and $N^{*++}\rho^-\pi^-$ are studied and the possibility of their production via a double-peripheral mechanism is described. Evidence for the $\pi^+\pi^-\pi^-$ decay modes of the R(1700) and T(2200) mesons is presented. An enhancement in the $\pi^+\pi^-$ effective-mass distribution at 400 MeV is discussed. (auth)

28497 π^-p ELASTIC SCATTERING BETWEEN 1.7 AND 2.5 GeV/c. Hill, Roger E. (Univ. of Chicago); Booth, Norman E.; Esterling, Robert J.; Suwa, Shigeki; Yokosawa, Akihiko. Contract Nonr 2121(25). Phys. Rev., D; 1: 729-58(1 Feb 1970).

The polarization and the differential cross section in π^-p elastic scattering were measured at incident pion laboratory momenta of 1.70, 1.88, 2.07, 2.27, and 2.50 GeV/c. The experiment was carried out at the Argonne zero-gradient synchrotron with a polarized

proton target. Details of the apparatus and data analysis are presented here together with the final results. A partial-wave analysis of the data has verified the $J^P = 7/2^+$ assignment for the $\Delta(1950)$ and established a $J^P = 7/2^-$ assignment for the N(2190). It does not support a $J^P = 11/2^+$ assignment for the $\Delta(2460)$, nor does it give support for some of the possible resonances found in the CERN phase-shift analysis. Apart from the resonance behavior, the partial-wave analysis reveals several new features. A striking correlation is found among the various partial-wave amplitudes at the highest energy, which is different for $J = l + 1/2$ and $J = l - 1/2$. In addition, several fixed-(−t) features of high-energy scattering emerge in the energy region of this analysis. (auth)

28498 FOUR- AND FIVE-BODY FINAL STATES FROM 6.7-GeV/c π^-p INTERACTIONS. Miyashita, S.; von Krogh, J.; Kopelman, J. B.; Libby, L. Marshall (Univ. of Colorado, Boulder). Contract AT(11-1)-1537. Phys. Rev., D; 1: 771-89(1 Feb 1970).

Approximately 9000 four-prong events produced by π^-p interactions at 6.7 GeV/c were analyzed. All the effective-mass distributions from final states $\pi^-\pi^-\pi^+$p, $\pi^-\pi^-\pi^+\pi^0$p, and $\pi^-\pi^-\pi^+\pi^+$n are presented, as well as cross sections. Resonances in each final state amount to more than 50% of total events, dominated by ρ mesons and $\Delta(1236)$ baryons. Three-pion mass distributions show strong signals in the A-meson region in all three final states, but only a modest enhancement is observed in the R-meson region. J^P of 0^- and 2^+ for the $A_{1.5}$ is ruled out. A similar analysis for the A_1 is consistent with 1^+. In the $\pi\rho$ and $\pi\eta$ mass distributions no evidence for A_2 structure is seen. Low-mass enhancements in four-pion mass distributions appear in the region of the B meson and the $\rho(1700)$ meson. There is also possibly some evidence for $f' \rightarrow 4\pi$. Higher-mass nucleon isobars are found to be closely associated with $\Delta(1236)$ production. There is no significant production of quasi-two-body final states. (auth)

28499 SEARCH FOR UNCHARGED FASTER-THAN-LIGHT PARTICLES. Baltay, C. (Columbia Univ., New York); Feinberg, G.; Yeh, N.; Linsker, R. Phys. Rev., D; 1: 759-70 (1 Feb 1970).

An experiment was carried out to search for uncharged particles with spacelike four-momentum which presumably travel faster than light. No evidence for such particles was found. The results can be expressed as upper limits on the production rates for such particles by stopped K^- and p compared to production rates of pions in similar reactions: $(K^- + p \rightarrow \Lambda^0 + t^0)/(K^- + p \rightarrow \Lambda^0 + \pi^0) \leq 2 \times 10^{-3}$, $(K^- + p \rightarrow \Lambda^0 + t^0 + t^0)/(K^- + p \rightarrow \Lambda^0 + \pi^0) \leq 2.5 \times 10^{-3}$, $(p + p \rightarrow \pi^+ + \pi^- + t^0)/(p + p \rightarrow 3\pi) \leq 2 \times 10^{-3}$, $(p + p \rightarrow \pi^+ + \pi^- + t^0 + t^0)/(p + p \rightarrow 4\pi) \leq 1 \times 10^{-3}$. Other sources of information placing limits on the interactions of tachyons are discussed. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 28587 and 28633.

28500 CONTRIBUTION TO THE DECAY THEORY OF UNSTABLE QUANTUM SYSTEMS. Fonda, L.; Ghirardi, G. C. (Univ., Trieste, Italy). Nuovo Cim.; 67A: 257-66(21 May 1970).

A definite physical prescription is given in order to obtain the wave function describing an unstable quantum system when this system is produced in a scattering experiment. In this way the connections between the two standard approaches found in the literature for the description of unstable systems are completely clarified. The procedure establishes a definite relation between the energy form factor of the unstable state and the T-matrix for the considered scattering process. The desired relation is derived in an exact way in potential scattering. Subsequently the same is performed for more general situations by making use of reasonable approximations. (auth)

28501 RELATIVISTIC POLARIZATION AND ANGULAR CORRELATIONS. Werle, J. (Univ., Warsaw). pp 85-127 of Scattering Theory. /Barut, A. O. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The discussion of relativistic polarization and angular correlations covers some basic properties of the collision phenomena, various spin representations for free-particle systems, and the general structure of the spin-density matrices. Polarization phenomena, angular distributions, and nondynamical spin and parity tests are also included. (J.F.P.)

Electromagnetic

Refer also to abstracts 28457, 28472, 28589, 28599, and 28651.

28502 (DESY-70/11) PION ELECTROPRODUCTION AND CHOICE OF FRAME IN THE VECTOR MESON DOMINANCE MODEL. Iso, C.; Schildknecht, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). American Univ., Beirut (Lebanon). Dept. of Physics). Feb 1970. 16p. Dep. CFSTI (U. S. Sales Only).

It is pointed out how forthcoming experiments on electroproduction of pions will provide additional information on the choice of the reference frame to be used to formulate the mass extrapolation assumption of the VDM in pion production processes. (auth)

28503 (ITF-70-10) PHOTOPRODUCTION OF THE NEUTRAL PSEUDOSCALAR MESONS ON NUCLEONS. Kobylinskii, N. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 15p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Within the framework of a model taking into account the contributions of ρ and ω Regge poles and of ρP and ωP cuts, the processes of photoproduction of π^0, η and X mesons on protons and neutrons were considered. A number of relations between differential cross sections of the meson production by the polarized and unpolarized photons, asymmetries in the angular distribution of mesons and polarizations of the recoil nucleons were obtained. (auth)

28504 (LA-4097) THICK TARGET BREMSSTRAHLUNG THEORY. Emigh, C. Robert (Los Alamos Scientific Lab., N. Mex.). Dec 1969. Contract W-7405-eng-36. 72p. Dep. CFSTI.

The calculations for thick target bremsstrahlung in the forward direction are presented. The theory presented is complete with regard to such details as multiple electron scattering, electron-energy degradation in the target, bremsstrahlung angular distribution, variation of bremsstrahlung distribution with a decreasing electron energy, and target self-absorption. Past theories have accounted for some, but not all, of these effects. The approximations presented are for heavy elements, particularly tungsten; they should also apply to the lighter elements but perhaps not with the same degree of accuracy. For the off-axis theory the same details are covered for the on-axis theory. The angular displacement of the detector from the axis is accounted for. The off-axis is useful in determining the optimum target-object distance for certain densitometric or radiographic observations. The distinguishing characteristics of this theory are that it is continuous for all thicknesses of target, zero to infinity; it is continuous for detector angle displacements, zero to values greater than the half-intensity angle; and it introduces a new energy-dependent parameter t', which is the lesser of either thickness or the distance traveled by an electron in the target and emitting a photon of energy k at the end of its range. Improvements are presented in the development of the off-axis theory covered including the effects of plural scattering, the transitional region between multiple and single scattering. The need for such improvements was indicated by the discrepancy between previous off-axis theories and the published experimental results. A surprising result is that terms added to account for plural scattering contribute only negligibly to the angular radiation distribution, which is in contrast to predictions. The long tail to the angular distribution is primarily a result of the convolution of the multiple-scattering angular distribution and the bremsstrahlung angular distribution. A weighting function is developed and compared with the experimental results; agreement with theory is within the experimental error. (auth)

28505 (LNF-69/58) UNITARITY AND VENEZIANO-LIKE PION FORM FACTOR. Note No. 452. Drago, F.; Grillo, A. F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 3 Oct 1969. 13p. Dep. CFSTI (U. S. Sales Only).

A unitarization method is studied in connection with the recently proposed Veneziano-like models for the pion electromagnetic form factor. Using as input the model proposed by Suura, good agreement is obtained with the experimental data in the time-like region. (auth)

28506 (LNF-69/64) TEST OF VECTOR MESON DOMINANCE MODEL IN THE COLLIDING BEAM REACTION $e^+ + e^- \rightarrow P + \gamma$. Note No. 454. Etim, E.; Picchi, P. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 27 Oct 1969. 11p. Dep. CFSTI (U. S. Sales Only).

The commutation rules of gauge field and quark field algebra

are used to derive sum rules for the electromagnetic form factors of the decays ($P \equiv \pi^0, \eta, X^0$) $\rightarrow \gamma + \gamma$ making use of the Bjorken limit theorem. Assuming that these sum rules can be saturated by vector meson poles and that the resultant form factors correctly describe the processes $e^+ + e^- \rightarrow P + \gamma$, $P \rightarrow e^+ + e^- + \gamma$, $P \rightarrow \gamma + \gamma$ in their appropriate kinematical regions it is found that the prediction of gauge field algebra (field-current identity) but not that of quark field algebra is in conflict with experiment in the reaction $e^+ + e^- \rightarrow \pi^0 + \gamma$. It is also shown that field-current identity fails to predict correctly the width $\Gamma(\pi^0 \rightarrow 2\gamma)$. (auth)

28507 CONCERNING ONE METHOD OF STUDYING RESONANCES IN MESON PHOTOPRODUCTION. Tsarev, V. A. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 11: 41-3(5 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu; 11: 65-7(5 Jan 1970).

Some problems connected with various attempts to observe new baryon resonances in the photoproduction of mesons on nucleons are noted. A method is proposed for the study of resonances in the photoproduction of mesons having two-photon decay. The method is based on measuring the contribution of the Primakoff effect to the cross section at small angles. (L.B.S.)

28508 THEORY OF THE CHERENKOV EFFECT IN COVARIANT FORMULATION. Magyari, E.; Trif, E. (Univ., Cluj. Univ. of Craiova, Rumania). Stud. Cercet. Fiz.; 22: 17-24 (1970). (In Rumanian).

A four-dimensional formulation is given for the theory of the Čerenkov effect by using Minkowski's equations from the electrodynamics of moving media. The vectors of the Čerenkov radiation field are obtained by Lorentz transformations acting on the field components from a frame moving together with the charged particle and the observer, with respect to which the medium is moving with a constant velocity. (auth)

28509 PHENOMENOLOGICAL MODEL FOR THE ELECTROMAGNETIC STRUCTURE OF THE PROTON. West, Geoffrey B. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 24: 1206-9(25 May 1970).

A phenomenological model of electron–proton scattering is developed which can account for the general qualitative and quantitative features of the data. Some interesting links between the elastic and inelastic form factors are discussed. (auth)

28510 THE CLASSICAL THEORY OF MESONIC CHERENKOV RADIATION IN NUCLEAR MEDIA. Ion, D. B. (Inst. of Nuclear Physics, Bucharest). Stud. Cercet. Fiz.; 22: 125-49 (1970). (In Rumanian).

The theory of the scalar and vector mesonic Cherenkov radiation, emitted by a mesonic charged particle moving in a nuclear medium of infinite extension is discussed in detail. (auth)

28511 NEW CONSTRAINTS IN HIGH-ENERGY ELECTRON–POSITRON ANNIHILATION INTO HADRONS. Pestieau, Jean; Terazawa, Hidezumi (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 24: 1149-52(18 May 1970).

Relations between the total cross section $\sigma_T(e^+ + e^- \rightarrow \text{hadrons})$ and the differential cross section for $e^+ + e^- \rightarrow H + \text{anything}$, where H is a hadron, are considered. New restrictions on inelastic form factors in the timelike region are obtained. It is shown that field algebra is incompatible with scale invariance à la Bjorken; experimental data are presented. (auth)

28512 TWO ASYMPTOTIC SUM RULES FOR ELECTROPRODUCTION AND PHOTOPRODUCTION. Cornwall, John M.; Corrigan, Dennis; Norton, Richard E. (Univ. of California, Los Angeles). Phys. Rev. Lett.; 24: 1141-3(18 May 1970).

A sum rule relating photoproduction to asymptotic electroproduction, and another electroproduction sum rule which tests for the presence of operator Schwinger terms are given. (auth)

28513 EFFECT OF ABSORPTION ON THE MASS AND LIFETIME OF UNSTABLE PARTICLES. Chapline, George (Univ. of California, Santa Cruz). Phys. Rev., D; 1: 949-52 (1 Feb 1970).

A formalism is developed to treat the effects of final-state interactions on the properties of unstable particles produced in high-energy collisions. The formalism is applied to the photoproduction of ρ mesons. (auth)

28514 DIFFERENTIAL CROSS SECTION FOR CHARGED A_1 PHOTOPRODUCTION USING THE REGGE EXCHANGE FORMALISM. Kikkawa, K. (Univ. of Rochester, N. Y.); Hale, B. Phys. Rev., D; 1: 903-7(1 Feb 1970).

The Regge-pole formalism is applied to the calculation of the differential cross section for A_1^+ photoproduction in the region $|t_{min}| < -t < 10\,\mu^2$. The ρ, A_1, A_1-daughter, A_2, and π trajectory contributions are considered, and use is made of chiral dynamics to estimate the unknown coupling constants. It is found that the π and the A_2 trajectories provide the dominant contributions. (auth)

28515 INTERACTION ANGULAR MOMENTUM AND CONSERVATION LAWS. Schmieg, G. M. (Univ. of Wisconsin, Milwaukee). Nuovo Cim.; 67B: 67-74(11 May 1970).

Relativistic angular momentum for a pair of charged particles is introduced. Because simultaneity is frame-dependent, several definitions of angular momentum are possible. These definitions are compared and their transformation properties are discussed. It is seen that these transformations do not require interaction angular momentum. However, when conservation laws are considered, interaction angular momentum is shown to play a necessary role. (auth)

28516 COHERENT BREMSSTRAHLUNG OF ELECTRONS IN CRYSTALS. Timm, U. (Deutsches Elektronen Synchrotron, Hamburg). Fortschr. Phys.; 17: 765-808(1969).

The interferential phenomena of high-energy bremsstrahlung in crystals are considered. It is explained how the kinematical restrictions of the process and the interferential selection of nuclear recoils act together to obtain an energy-proportional intensity spectrum and high linear polarization. Formulas for intensity and polarization as a function of the quantum energy are presented and discussed, particularly with respect to experimental limitations. Apart from previous work, the discussion is based on experimental and theoretical investigations carried out at Deutsches Electronon Synchrotron, Hamburg, at electron energies of 6 GeV. (auth)

28517 DUAL-RESONANCE ANALYSIS OF DIFFRACTIVE TWO-PION PHOTOPRODUCTION. Satz, H.; Schilling, K. (CERN, Geneva). Nuovo Cim.; 67A: 511-22(1 Jun 1970).

A recently proposed dual-resonance model for diffraction dissociation is extended to two-pion photoproduction on protons and shown to give good agreement with experimental data. It yields vector-meson dominance in the sense of a strongly ρ-dominated two-pion mass spectrum and moreover explains the observed deviation of the ρ peak from a Breit-Wigner shape as well as the background. Further experimental tests are proposed. (auth)

28518 PHASE-SHIFT INFORMATION FROM RADIATIVE DECAYS. Conway, P. D. (Princeton Univ., N. J.). Contract AF 49(638)-1545. Nuovo Cim.; 67A: 497-510(1 Jun 1970).

The present methods available for obtaining phase-shift information for a process in which the scattering particles are unstable with respect to the weak or electromagnetic interactions are reviewed. Decays of the form $A \rightarrow B + C + \gamma$ are investigated. It is shown that these do not provide information except in the cases $\eta \rightarrow 2\pi\gamma$ and $\Xi \rightarrow \Lambda\pi\gamma$. In the latter case a consistency check is obtained on the $\Lambda\pi$ phase shifts derived (e.g.) from Ξ_{e4} decay by the Pais-Treiman method. (auth)

28519 DUALITY AND FIXED POLES IN PION PHOTOPRODUCTION. Bender, I. (Univ., Heidelberg); Rothe, H. J.; Dosch, H. G.; Mueller, V. F. Lett. Nuovo Cim.; 3: 625-9(9 May 1970).

Some aspects of the duality concept are applied to charged pion photoproduction off nucleons. Photoproduction is considered to emerge from electroproduction by replacing the electron vertex times the photon propagator by the polarization vector of the photon, and taking $q^2 = 0$. Emphasis is placed on the fixed-power behavior for high-energy photoproduction at fixed values of $|t| < 1$ $(GeV)^2$. The predictions are compared with the sum of π^+ and π^- photoproduction cross sections. (L.B.S.)

28520 PHENOMENOLOGICAL ANALYSIS OF THE SINGLE π^- PHOTOPRODUCTION IN THE SECOND-RESONANCE REGION. Proia, A.; Sebastiani, F. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). Lett. Nuovo Cim.; 3: 483-8(11 Apr 1970).

Using a previous generalized isobar model, a phenomenological analysis was made of single π^- photoproduction in the reaction $\gamma + n \rightarrow p + \pi^-$ in the second resonance region. A clear dominance of the isovector components is evident. Previsions are also made on the $\gamma + n \rightarrow n + \pi^0$ reaction, and the angular distributions are summarized. (J.F.P.)

28521 GROUP-THEORETICAL ANALYSIS OF ELEMENTARY PARTICLES IN AN EXTERNAL ELECTROMAGNETIC FIELD. I. THE RELATIVISTIC PARTICLE IN A CONSTANT AND UNIFORM FIELD. Bacry, H. (Univ. de Marseille, Luminy, France); Combe, Ph.; Richard, J. S. Nuovo Cim.; 67A: 267-99(21 May 1970).

Two subgroups of the Poincaré group are shown to play a par-

ticular role in the case of charged systems in an external electromagnetic field which is constant and uniform. Projective representations of these subgroups involve the electric charge as a generator of a phase factor. Additivity and superselection rules for charge appear as direct consequences. (auth)

Weak

Refer also to abstracts 28518 and 28578.

28522 (LNF-69/56) IMPLICATIONS OF DEEP INELASTIC MUON-NUCLEON SCATTERING ON COSMIC-RAY PHENOMENA. Note No. 450. Castagnoli, C.; Etim, E.; Picchi, P. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 22 Sep 1969. 7p. Dep. CFSTI (U. S. Sales Only).

The Weizsaker-Williams approximation and improvements theory, according to which the cross section for the absorption of transverse photons on a nucleon can be expanded in a convergent series for small values of the invariant momentum transfer, is discussed. It is shown that the validity of this relation is very much in doubt. This is shown by the analysis of cosmic ray experiments for large values of the photon energy. It is also shown that the Bjorken inelastic sum rule for asymptotic cross sections is not saturated. (J.F.P.)

28523 MODEL OF UNIFIED WEAK AND STRONG INTERACTIONS ON BASIS OF THE BROKEN (V ∓ A) SYMMETRY. Lipmanov, E. M. (Volgograd Pedagogical Inst., USSR). Yadern. Fiz.; 11: 648-56(Mar 1970). (In Russian).

An attempt is made to describe weak and strong elementary particle interactions in a unified and nontrivial way in framework of the new approach to the theory of weak interactions, presented previously. It is shown that assuming the broken (V ∓ A) symmetry for the interactions of currents with intermediate vector and scalar fields one is able in fact to discriminate the current-current interactions of the elementary particles in two classes: regular "nondiagonal" interactions describing all the known up to now weak processes, and singular "diagonal" interactions. The hadron part of the last, transferred by scalar intermediate bosons, in the present model has all the known symmetries attributed to the observed strong nuclear interactions and may have an arbitrarily strong coupling constant. (auth)

28524 WEAK INTERACTIONS. Invited Papers Presented at the Second International Summer School for Theoretical Physics, University of Karlsruhe, July 14-August 1, 1969. Hoehler, G. (ed.). Springer Tracts in Modern Physics. Ergebnisse der Exakten Naturwissenschaften, Volume 52. Berlin; Springer-Verlag (1970). 218p.

Available from Springer-Verlag New York, Inc., New York.

Twelve invited papers presented at the second international Summer School for Theoretical Physics are included; a separate abstract is prepared for each paper. (L.B.S.)

For abstracts of individual papers see: 28525-28534, 28577, and 28591.

28525 SURVEY OF THE WEAK INTERACTIONS. Gasiorowicz, S. (Deutsches Elektronen Synchrotron, Hamburg. Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1764. Ergeb. Exakten Naturwiss.; 52: 1-33(1970).

A survey of the weak interactions is made in order to show how the present ideas evolved and how they are related to each other. The topics discussed include the weak interactions before 1957, parity nonconservation and the form of the beta interaction, currents and their symmetries, nonleptonic decays, and some concluding remarks concerning a coherent picture of the weak interactions. (L.B.S.)

28526 SEMILEPTONIC DECAYS. Mueller, Volkhard F. (Univ., Bonn). Ergeb. Exakten Naturwiss.; 52: 34-49(1970).

A comprehensive survey of the theoretical description of leptonic and semileptonic decays is presented. It is assumed that these weak interaction processes can be treated in first order perturbation theory, where the weak interaction transition amplitudes are linearly related to the corresponding matrix elements of the weak interaction Lagrangian density. The topics discussed include the effective Lagrangian, universality, baryon decays, and the Ademollo-Gatto theorem. (L.B.S.)

28527 NON LEPTONIC DECAYS. Stech, Berthold (Univ., Heidelberg). Ergeb. Exakten Naturwiss.; 52: 50-9(1970).

A critical discussion is given on the theoretical description presently employed to describe nonleptonic decays. The conventional form of the nonleptonic weak interaction is first presented. The results of model treatments for p- and s-wave hyperon decays are presented. The current algebra attempt to relate s- and p-wave amplitudes is discussed. Serious inconsistencies which show up are discussed. The expected fraction of the decay amplitude in each channel for which violations of the $|\Delta I| = 1/2$ rule should occur if the weak interaction contains charged currents only is presented in the last section. (L.B.S.)

28528 CURRENT ALGEBRA AND WEAK INTERACTIONS. Renner, B. (Cambridge Univ., Eng.). Ergeb. Exakten Naturwiss.; 52: 60-78(1970).

The basic principles of current algebra and their application to weak interactions are discussed. Topics include: sum rule tests; low energy theorems; K_{13} decay; K_{14} decay; and the structure of low energy theorems. (L.B.S.)

28529 THE DECAY OF THE K_0-anti K_0 SYSTEM. Dosch, H. G. (Kernforschungszentrum, Karlsruhe, Ger. Univ., Heidelberg). Ergeb. Exakten Naturwiss.; 52: 79-90(1970).

The problem of decaying quantum mechanical states is discussed with particular emphasis on the decay of the neutral K-mesons. The Weisskopf-Wigner method is discussed in detail and applied to the $K_0\bar{K}_0$ system. A more direct approach to the problem of decaying states is discussed, following the method of Höhler for exponential decay. (L.B.S.)

28530 RELATIONS FOR SEMILEPTONIC WEAK INTERACTIONS INVOLVING PHOTONS. Kummer, W. (Oesterreichische Akademie der Wissenschaften, Vienna. Technische Hochschule, Vienna). Ergeb. Exakten Naturwiss.; 52: 113-25 (1970).

By means of a low energy theorem type consideration a description of electromagnetic symmetry breaking for the vector parts in those semileptonic weak interactions can be given, where also a photon is emitted. The examples $\pi \to e\nu\gamma$ and $\pi^+ \to \pi^0 e\nu\gamma$ are discussed. (auth)

28531 RADIATIVE CORRECTIONS TO WEAK DECAYS INVOLVING LEPTONS. Riazuddin (Univ. of Islamabad, Rawalpindi, Pakistan. International Centre for Theoretical Physics, Trieste, Italy). Ergeb. Exakten Naturwiss.; 52: 126-60 (1970).

The problem of radiative corrections to leptonic weak decays is treated, with particular emphasis on computing second-order radiative corrections to first-order weak interactions. The case of μ-decays and, more generally, the case of the β-decay of a point-like particle of arbitrary charge are discussed. Radiative corrections and divergences for $\Delta Y = 0$ and $|\Delta Y| = 1$ semileptonic processes are treated. (L.B.S.)

28532 RADIATIVE CORRECTIONS TO WEAK INTERACTIONS. Rothleitner, J. (Univ., Innsbruck). Ergeb. Exakten Naturwiss.; 52: 161-70(1970).

A discussion is given of the finite radiative correction to low energy beta decay. Also a general discussion of the radiative corrections to purely leptonic weak interactions is given. An attempt is made to gain insight into the fundamental question of whether the divergences have their origin in an inconsistent form of the weak Lagrangian or in the inability to treat quantum electrodynamics in the correct way. (L.B.S.)

28533 UNCONVENTIONAL MODELS OF WEAK INTERACTIONS. Segre, Gino (Univ. of Pennsylvania, Philadelphia). Ergeb. Exakten Naturwiss.; 52: 171-92(1970).

Renormalizable models for weak, semileptonic, and nonleptonic interactions are examined. The following nonrenormalizable models are also examined: strongly interacting W mesons; schizon models; model with cutoff $\Lambda \sim (\sqrt{G_F})^{-1}$; and W mesons and scalar mesons with derivative coupling. (L.B.S.)

28534 WEAK INTERACTIONS AT SMALL DISTANCES. Pietschmann, H. (Institut fuer Theoretische Physik, Vienna). Ergeb. Exakten Naturwiss.; 52: 193-200(1970).

An S-operator for weak interactions is suggested which includes possible nonlocal structure effects. Leptonic and semileptonic processes are analyzed with this S-operator and a parametrization of the electron spectrum in μ-decay is suggested, which allows for an experimental detection of such effects. (auth)

28535 LEPTONIC DECAYS OF K MESONS. Hara, Yasuo (International Centre for Theoretical Physics, Trieste, Italy. Univ. of Maryland, College Park). Phys. Rev., D; 1: 874-6 (1 Feb 1970).

By making use of current algebra, K_{13} decay amplitudes are deduced from the K_{14} decay amplitudes in the generalized Veneziano model. For K_{13} decays, it is predicted that $\lambda_+ = m_\pi^2/m_K^2$, and that $\xi(t) = f^-(t)/f^+(t) = c(t - m_K^2) - 0.009\ t/m_K^2$, where c is a free parameter. (auth)

28536 REGGE MODEL IN HIGH-ENERGY LEPTON PROCESSES. Pais, A. (Rockefeller Univ., New York); Treiman, S. B. Contract AF 49(638)-1545. Phys. Rev., D; 1: 907-15 (1 Feb 1970).

The application of Regge-model ideas to high-energy semileptonic reactions is taken up in some detail for the process $\nu + p \rightarrow \mu^- + p + \pi^+$ (and its electroproduction analogs), and, qualitatively, for more complicated processes of the sort $\nu + p \rightarrow \mu^- + p + X_1 + X_2 + \ldots\ldots$ (auth)

Strong (General)

Refer also to abstract 28466.

28537 (ITF-70-20) REMARKS ON THE BROKEN NONLINEAR CHIRAL U(3) x U(3) DYNAMICS OF HADRONS. Sabo, V. I.; Lomsadze, Yu. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 14p. Dep. CFSTI (U. S. Sales Only).

In contrast to previous work the broken nonlinear chiral U(3) × U(3) dynamics of strong, electromagnetic and weak interactions of hadrons is considered in the most general form. Such a general consideration reduces the number of predictions only but does not change them. (auth)

28538 BARYON MASS SPECTRA AND BARYON COUPLINGS. Matsuda, Seisaku (Univ. of Maryland, College Park. Polytechnic Inst. of Brooklyn); Oneda, S. Phys. Rev., D; 1: 944-8 (1 Feb 1970).

General intermultiplet mass formulas between the decuplet and octet baryons are derived, based on the chiral SU(3) ⊗ SU(3) charge algebra and the asymptotic SU(3) symmetry imposed only on the charge operator V_K which is the SU(3) raising or lowering operator in the symmetry limit In the absence of particle mixing, the formulas take on a simple form and are useful as a first guide in deducing baryon mass spectra. Inclusion of a particle mixing is possible. The formulas imply that the equal squared-mass spacings of decuplet states $(\delta_a)^2$ (a specifies the quantum numbers of the a decuplet) are universal [i.e., $(\delta_a)^2$ = const] and, furthermore, equal to the universal spacings of the Ξ and Σ members of any octet baryons. In the case of the usual $\frac{1}{2}^+$ and $\frac{3}{2}^+$ baryons, the formulas coincide with the well-known SU(6) mass formula. Broken-SU(3) sum rules (in the absence of mixing) for general transitions of the form (octet baryon) → (octet baryon) + π (or l + $\bar{\nu}$) are also obtained. In particular, the strong decays, $\frac{3}{2}^- \rightarrow \frac{1}{2}^+ + \pi$ and $\frac{3}{2}^+ \rightarrow \frac{1}{2}^+ + \pi$, are discussed in detail. The sum rules, in general, give rise to significant SU(3)-breaking effects. However, for the familiar axial-vector $\frac{1}{2}^+ \rightarrow \frac{1}{2}^+ + l + \bar{\nu}$ transitions, the broken-SU(3) sum rules assume the same forms as satisfied by the hypothetical exact SU(3) couplings. This justifies the use of the original Cabibbo analysis [in broken-SU(3) symmetry] in determining the value of the axial-vector Cabibbo angle. (auth)

28539 TWO OVERLAPPING RESONANCES: PRODUCTION AND DECAY IN S-MATRIX THEORY. Dothan, Y.; Horn, D. (Tel-Aviv Univ., Israel). Phys. Rev., D; 1: 916-25(1 Feb 1970).

The system of two overlapping resonances is discussed along two parallel lines: (A) the general restrictions imposed on the S matrix by unitarity, and (B) the results of the Weisskopf-Wigner approximation. The equivalence between the two is used to get a physical understanding of the formalism applicable to both scattering and decay processes. It is shown that the connection between the overlap in channel space, χ_C, and the overlap of the two resonances, χ, is the unitarity sum role. (auth)

28540 EXTENSION OF THE WEINBERG ALGEBRAIC RELATIONS FOR PION PROCESSES. Kloet, W. M.; Zimerman, A. H. (Istituto de Fisica Teorica, Sao Paulo, Brazil). Lett. Nuovo Cim.; 3: 619-21(9 May 1970).

The algebraic structure of matrix elements related to collinear processes involving pions is examined. (L.B.S.)

Strong (Baryon No. = 0)

Refer also to abstract 28569.

28541 (JINR-E4-4959) VENEZIANO MODEL FOR THE OFF-MASS-SHELL $A_1\pi \rightarrow \pi\pi$ AMPLITUDE. Csikor, F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 29p. Dep. CFSTI (U.S. Sales Only).

A Veneziano-type model for the off-mass-shell $A_1\pi \rightarrow \pi\pi$ amplitude is obtained. At the same time any two of the masses are allowed to be off-shell. The model has all the expected good properties of off-shell Veneziano amplitudes, notably it has only the required poles in all the variables, satisfies the PCAC equation exactly, and is compatible with current algebra. (auth)

28542 LOW ENERGY PHASES OF s-WAVE ππ INTERACTION AND DETERMINATION OF CHARGE EXCHANGE AND OF NEUTRAL MESON ELASTIC SCATTERING CROSS SECTIONS. Makarov, M. M.; Gasilova, N. S.; Nelyubin, V. V.; Sarantsev, V. V.; Tkach, L. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 11: 608-12(Mar 1970). (In Russian).

Phase-shift analysis of the ππ scattering at low energy made based on the total cross section of reactions $\pi^+\pi^- \rightarrow \pi^+\pi^-$, $\pi^\pm\pi^0 \rightarrow \pi^\pm\pi^0$, $\pi^\pm\pi^\pm \rightarrow \pi^\pm\pi^\pm$ are determined by means of Chew and Low method. Moduli of the phases δ_0^0 and δ_0^2 in the energy region 300-500 MeV are calculated. Cross sections of elastic scattering and of charge exchange of π^0-mesons are estimated. (auth)

28543 DECAY V → P + $l^+ + l^-$. Zima, V. G. (Donetsk Inst. of Physics and Tech., USSR). Ukr. Fiz. Zh.; 15: 251-6(Feb 1970). (In Russian).

The radiative decays of the vector mesons V → P + $l^+ + l^-$ are considered in the vector-dominance model. The partial widths for these decays obtained herein show that experimental study of these decays is possible. (auth)

28544 DUALITY AND UNNATURAL-PARITY TRAJECTORIES. Dass, G. V.; Jacob, M.; Papageorgiou, S. (CERN, Geneva). Nuovo Cim.; 67A: 429-36(1 Jun 1970).

Global duality arguments can have but a limited value when applied to the low-intercept unnatural-parity trajectories. Difficulties which then arise are analyzed. Information on the isospin-0 ρπ channel would help choosing between different schemes. (auth)

28545 THEORETICAL BASIS FOR HIGHER VECTOR MESONS. Dobson, P. N. Jr.; Tuan, S. F. (Univ. of Hawaii, Honolulu). Nuovo Cim.; 67A: 474-82(1 Jun 1970).

The existence of vector mesons of higher mass is an interesting theoretical and experimental question. The predictions and implications for this problem of a number of currently interesting theoretical approaches are reviewed. (auth)

28546 $\bar{p}n \rightarrow 3\pi$, $K \rightarrow 3\pi$, $\eta \rightarrow 3\pi$, AND $X^0 \rightarrow \eta\pi^+\pi^-$ DECAYS IN A CROSSING-SYMMETRIC REGGE-POLE MODEL. Moen, I. O.; Moffat, J. W. (Univ. of Toronto). Lett. Nuovo Cim.; 3: 473-82 (11 apr 1970).

The Moffat model is applied to the decays $\bar{p} + n \rightarrow \pi^+ + \pi^- + \pi^-$, $K \rightarrow \pi^+ + \pi^- + \pi^0$, $\eta \rightarrow \pi^+ + \pi^- + \pi^0$, and $X^0 \rightarrow \eta + \pi^+ + \pi^-$. This model interpolates between the low-energy region and the asymptotic Regge behavior and maintains crossing symmetry for the $\pi - \pi$ system. (J.F.P.)

28547 SINGULAR POTENTIALS. Calogero, F. (Univ., Rome). pp 47-51 of Scattering Theory. /Barut, A. O. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The singular-potential problem in scattering theory is discussed. Singular potentials are defined, and the differences in the associated scattering theory treatment are considered. Applications to elementary particles, and a convergent iterative approach to the problem are given. Only S-wave scattering is treated. (J.F.P.)

Strong (Baryon No. = 1)

28548 (JINR-P2-4987) NUCLEON-MESON MODEL OF BARYONS WITH THE MASS SMALLER THAN 2 GeV. Dushenko, V. F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Some empirical regularities in the spectrum of baryons of small masses, which are revealed when such baryons are considered to be the compounds of a nucleon-meson system, are discussed. The character of these regularities proves the possibility of existence of a model of the shell type. The systems with mesons π,K,η stable with respect to the strong decays are considered. (auth)

28549 (SU-1206-224) IMPLICATIONS OF LOCAL DUALITY IN MESON-DECUPLET SCATTERING. King, M. J.; Wali, Kameshwar, C. (Syracuse Univ., N. Y. Dept. of Physics). Mar 1970. 9p. (NYO-3399-224). Dep. CFSTI.

The consequences of the assumption that the imaginary parts of the direct channel helicity amplitudes vanish in the forward (backward) scattering if the crossed t-channel (u-channel) is exotic, are examined in the case of meson-decuplet scattering. With restriction to a limited energy region above the threshold, it is shown that the solutions of the set of equations provided by different external helicities predict the existence of certain patterns of octet

and decuplet baryons degenerate in mass and having spin parity assignments $\frac{3}{2}^+$, $\frac{3}{2}^+$, $\frac{1}{2}^+$. (auth)

28550 SHOWER ENHANCEMENT OF BRANCH-POINT CONTRIBUTION AND INCREASE OF TOTAL CROSS SECTIONS AS $A \to \infty$. Lendel, A. L.; Ter-Martirosyan, K. A. JETP Lett. (USSR) (Engl. Transl.); 11: 45-8(5 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu; 11: 70-5(5 Jan 1970).

The values of the total πN and K^-N cross sections obtained with the Serpukhov accelerator at 40 to 60 GeV were found to be higher than the Regge pole curves or the curves of the optical or eikonal approximation. It is shown that these values can be understood within the framework of the scheme of complex angular momentum under the following conditions: (a) the values of α'_P (0) and α_ω (0) are shifted; (b) the residue of the P pole is greatly increased; and (c) besides the optical approximation diagrams, account is taken also of the diagrams that correspond to shower production upon rescattering, which greatly increase the contribution of the branch points. (L.B.S.)

28551 REGENERATION OF K^0 MESONS AND THE POMERANCHUK THEOREM. Gershtein, S. S.; Kobzarev, I. Yu.; Okun, L. B. JETP Lett. (USSR)(Engl. Transl.); 11: 48-50(5 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu; 11: 75-80(5 Jan 1970).

It is pointed out that the hypothesis $\delta_{KN} - \sigma_{\overline{K}N} = \text{constant} \neq 0$ as $E \to \infty$ leads to a number of distinct predictions pertaining to K^0 regeneration. The need for regeneration experiments to confirm these predictions is noted. (L.B.S.)

28552 π^-p ELASTIC SCATTERING FROM 1225 TO 2070 MeV/c COMPARED WITH PHASE SHIFT ANALYSIS. Kemp, M. A. R. (Daresbury Nuclear Physics Lab., Eng.); Ward, D. L. Phys. Lett.; 31B: 613-16(27 Apr 1970).

New π^-p differential cross sections are compared with the CERN phase shifts. Agreement is generally good but some changes are required, including cases where previous data sets disagreed. (auth)

28553 PION NUCLEON PHASE SHIFT ANALYSIS UP TO 2.8 GeV/c. Ayed, R.; Bareyre, P.; Villet, G. (CEN, Saclay, France). Phys. Lett.; 31B: 598-602(27 Apr 1970).

A pion-nucleon elastic scattering phase shift analysis was performed up to 2.8 GeV/c pion laboratory momentum. Recent experimental data were included and the "continuity" of the solution with energy was investigated with special care. (auth)

28554 ρ MESON IN LOW-ENERGY PION–NUCLEON SCATTERING. Huang, J. C. (International Centre for Theoretical Physics, Trieste, Italy); Urani, J. R. Phys. Rev., D; 1: 877-82(1 Feb 1970).

The low-energy, pion-nucleon scattering is studied by including the ρ-meson contribution to the axial-vector amplitude. By using a different treatment for the ρ contribution and the q^2 extrapolation, the results for the a_{1-}-scattering length and b_{1+}-effective range are improved while the results for the a_{3+}- and a_{1+}-scattering lengths are preserved. An explanation is also given of why there is no double counting of the ρ-meson contributions in pion-nucleon interactions when considering current-algebra and ρ-exchange models. (auth)

28555 ELECTROMAGNETIC DECAYS OF BARYON RESONANCES IN THE SYMMETRIC QUARK MODEL. Bowler, K. C. (Univ. of Edinburgh, Scotland). Phys. Rev., D; 1: 926-33 (1 Feb 1970).

The radiative decays of the $D_{13}(1515)$, $S_{11}(1525)$, $F_{15}(1690)$, and $Y_1^*(1520)$ resonances are studied within the framework of the symmetric quark model with harmonic-oscillator wave functions. It is pointed out that if it is assumed that the quarks have large anomalous magnetic moments, then it becomes necessary to consider the so-called "spin-orbit" term in the nonrelativistic electromagnetic interaction Hamiltonian. Including the effect of this term, it is shown that it is possible to understand the vanishing contribution of the $D_{13}(1515)$ resonance to backward or forward pion photoproduction in terms of a cancellation between electric and magnetic multipoles. Requiring such a cancellation gives a value of the oscillator range parameter, $\alpha = 105$ MeV. Using this value and assuming that the quark scale magnetic moment μ is equal to the proton moment, the multipole amplitudes involved in the decays of interest are calculated, and the results for the $D_{13}(1515)$ and $S_{11}(1525)$ resonances are compared with the recent phenomenological multipole analysis by Chau, Dombey, and Moorhouse of pion photoproduction in the second resonance region. Agreement is reasonably good. For the $Y_1^*(1520)$ a radiative width $\Gamma_\gamma = 0.051$ MeV to be compared with a recent experimental result $\Gamma_\gamma = 0.015 \pm 0.03$ MeV, and an angular distribution compatible with experiment are obtained. Comments are made on the contribution of the $F_{15}(1690)$ resonance to pion photoproduction. (auth)

28556 REGGEIZED $U(6) \otimes U(6) \otimes O(3)$ AND ABSORPTIVE CORRECTION CUTS FOR $K^+n \to K^0p$. Hartley, B. J.; Moore, R. W.; Moriarty, K. J. M. (Imperial Coll. of Science and Tech., London). Phys. Rev., D; 1: 954-5(1 Feb 1970).

The calculations of a previous paper on Reggeized $U(6) \otimes U(6) \otimes O(3)$ and absorptive corrections are extended to $K^+n \to K^0p$ at 5.5 GeV/c with the addition of no new parameters. Good agreement with experiment is obtained. (auth)

28557 FINITE-TRANSFORM SUM RULES. Chavda, L. K. (Purdue Univ., Lafayette, Ind.). Lett. Nuovo Cim.; 3: 622-4 (9 May 1970).

New sum rules based on Hankel, Fourier, Laplace, and other transforms are presented and applied to pion-nucleon scattering. (L.B.S.)

28558 LINEAR FERMION TRAJECTORIES AND ABSENCE OF MACDOWELL DOUBLETS. Minkowski, P. (Schweizerisches Institut fuer Nuklearforschung, Zurich). Lett. Nuovo Cim.; 3: 503-8(11 Apr 1970).

It is shown that the primary trajectory has a definite reflection on partial waves which could form a secondary trajectory and that no particle poles are generated in the secondary partial waves, that is, the absence of MacDowell doublets. Parity coupling in $\pi + N$ scattering is discussed. (J.F.P.)

28559 CONSTANT, INCREASING, AND DECREASING TOTAL CROSS-SECTIONS AT LARGE BUT FINITE ENERGIES. Saleem, M. (Panjab Univ., Lahore). Lett. Nuovo Cim.; 3: 667-71(23 May 1970).

Elastic scattering is considered at large but finite energy where the total cross section is constant, increasing, or decreasing toward its constant asymptotic value. Relations between particle and antiparticle total cross sections and phases are considered. Some specific hadron processes are discussed. (J.F.P.)

28560 FORMATION AND DECAY OF NEGATIVE-PARITY BARYON RESONANCES IN A BROKEN U_6 MODEL. Abramsky, J. (Univ. of Kent, Canterbury, Eng); King, R. C. Nuovo Cim.; 67A: 153-216(21 May 1970).

The formation and decay of negative-parity baryon resonances consisting of four quarks and one antiquark are considered in detail within the framework of broken $U_{6,6}$. A generalization of Young tableaux, reflecting the quark-antiquark structure of the particle states, is introduced. This generalization provides a convenient and illuminating method for discussing the irreducible representations of $U_{6,6}$ and its subgroups associated with the particle state functions. From a study of three-point vertex functions and the angular distributions associated with the formation and decay of negative-parity baryon resonances it is concluded that there is no evidence invalidating a broken $U_{6,6}$ model in which these experimentally observed resonances are interpreted as four-quark–one-antiquark states. (auth)

Strong (Baryon No. ≥ 2)

28561 (LYCEN–7005) ON THE ELEMENTARY PARTICLE TREATMENT OF MUON CAPTURE AND RADIATIVE PION CAPTURE IN ^{6}Li. Delorme, J. (Lyon Univ. (France). Institut de Physique Nucleaire). 16 Feb 1970. 21p. Dep. CFSTI (U. S. Sales Only).

The elementary particle approach to muon capture and radiative pion capture in nuclei is discussed for the particular case of the transition between the ground states of ^{6}Li and ^{6}He. Its validity is proved by comparison with standard calculations in the impulse approximation. The calculated capture rates are found to be consistent with the experimental data in contradistinction to previous estimates. (France)

28562 (ORNL-4542) AN EXTRAPOLATION METHOD FOR PREDICTING NUCLEON AND PION DIFFERENTIAL PRODUCTION CROSS SECTIONS FROM HIGH-ENERGY (>3 GeV) NUCLEON–NUCLEUS COLLISIONS. Gabriel, T. A.; Alsmiller, R. G. Jr.; Guthrie, M. P. (Oak Ridge National Lab., Tenn.). May 1970. Contract W-7405-eng-26. 71p. Dep. CFSTI.

An extrapolation procedure which relates the differential cross sections for nucleon and pion production from nucleon–nucleus collisions at energies >3 GeV to the differential cross sections for nucleon and pion production from 3-GeV nucleon–nucleus collisions is described. Calculated results for 3-GeV nucleon–nucleus collisions obtained from the intranuclear-cascade model of nuclear reactions are used in conjunction with the extrapolation procedure to obtain differential cross sections which may be compared with the experimental data from high-energy (12.5-

70 GeV) collisions. In some instances the agreement between the calculated and the experimental data is very good, but this is not always the case. (auth)

28563 HYPERNUCLEI. Curelaru, Irina (Inst. of Nuclear Physics, Bucharest). Stud. Cercet. Fiz.; 22: 77-103(1970). (In Rumanian).

The discussion of hypernuclei covers hypernuclei production and detection including the absorption of energetic negative kaons, the capture of K^- mesons and Σ^- hyperons at rest, proton–nucleus and π^-–nucleus reactions. Hypernucleus decay is studied including pionic, nonmesic, and leptonic decay. Also treated are hypernucleus lifetime and binding energy for the Λ N interaction, hypernuclei spin, the KΛ relative parity, double hypernuclei, the $\Lambda\Lambda$ interaction, and excited hypernuclei. (J.F.P.)

28564 DISPERSION SUM RULES FOR PROTON–PROTON SCATTERING. Lendel, A. I.; Lend'el, V. I. (Uzhgorod State Univ., USSR). Yadern. Fiz.; 11: 669-72(Mar 1970). (In Russian).

The validity of finite energy dispersion sum rules for pp scattering is tested. These sum rules are valid at conventional values of low and high energy parameters of NN scattering. The sensitivity of the sum rules to the Regge pole parameters is underlined. (auth)

28565 MULTIPARTICLE COLLISIONS AT HIGH ENERGIES. Walker, W. D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev. Lett.; 24: 1143-6(18 May 1970).

The hadronic cascade of high-energy particles in nuclei is discussed. As the incident energy of the bombarding particles is increased, a larger fraction of the products of the first collision strike the second nucleon. In a few successive collisions of relatively small momentum transfers in which the bombarding mass is increased, it is possible to double the energy available in the center-of-mass system. This can conceivably be a very useful analytical tool at high energies. (auth)

28566 CONSISTENCY CONDITIONS FOR PROTON–PROTON SCATTERING AT LARGE MOMENTUM TRANSFER. Chew, H. (Clarkson Coll. of Tech., Potsdam, N. Y.). Phys. Rev., D; 1: 953-4(1 Feb 1970).

Some recent results of Abarbanel, Drell, and Gilman on high-energy proton–proton scattering are shown to be the consequence of a general property of the Baker–Blankenbecler approximation for the unitarity condition they used. The latter approximation is shown to give results generally consistent with earlier suggestions of Wu and Yang. (auth)

28567 RADIATION-TYPE EIKONAL MODEL FOR UNCORRELATED MESON PRODUCTION IN HIGH-ENERGY NUCLEON–NUCLEON COLLISIONS. Heckman, Philip E. (Argonne National Lab., Ill. Univ. of Chicago). Phys. Rev., D; 1: 934-44 (1 Feb 1970).

A model for uncorrelated meson production in high-energy nucleon–nucleon collisions is proposed, using the eikonal formalism to extract a specific form for the optical potential from nucleon–nucleon elastic scattering data. This potential is used to form the eikonal wave function of the scattering system, from which is constructed a model source density for radiated pions. The normalization is derived from Adler's formulation of the soft-pion limit. Predications involving no free parameters are compared with pion spectra from $pp \rightarrow \pi^+ +$ anything at 12.2, 19.2, and 30 GeV/c. Good to reasonable agreement is obtained for c.m. emission angles less than 20°. The mean multiplicity for charged pions is also found to agree qualitatively with experiment. A covariant formulation of the model, using the Bethe–Salpeter equation, is proposed, but no calculations are presented. (auth)

28568 ON THE STRUCTURE OF THE FORWARD PEAK OF ELASTIC PROTON–PROTON SCATTERING. Kawasaki, M.; Kobayashi, M.; Yonezawa, M. (Hiroshima Univ.). Lett. Nuovo Cim.; 3: 655-7(23 May 1970).

Some possible origins of the structure of the forward peak in the proton–proton elastic-scattering differential cross section in the small-momentum transfer region are considered. The scattering of spinless protons is discussed. (J.F.P.)

28569 PHENOMENOLOGICAL ANALYSIS OF MULTIPARTICLE PRODUCTION REACTIONS. Fraser, G.; Gotsman, E.; Hirshfeld, A. C. (Tel Aviv Univ., Israel). Nuovo Cim.; 67A: 321-35(21 May 1970).

A model is proposed for calculating multiparticle production amplitudes. Resonances are taken into account in a multi-Regge framework in a way which is consistent with duality requirements. The procedure is successfully applied to processes involving multiple pion production in nucleon–nucleon and nucleon–antinucleon reactions. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 28591.

28570 (AD-687539) ON A GROUP THEORETICAL CONNECTION AMONG THE PHYSICAL HIERARCHIES. Research Communication No. 96. Sankaranarayanan, A. (McDonnell Douglas Corp., Huntington Beach, Calif. Douglas Advanced Research Labs.). Apr 1969. 34p. CFSTI.

The question whether one can extend the nonrelativistic homogeneous Galilei group to the relativistic homogeneous Lorentz group and then to the cosmological DeSitter group in an ascending fashion is raised and answered in the affirmative. (auth)

28571 (DESY-70/10) ASYMPTOTIC LOCALITY AND THE STRUCTURE OF LOCAL INTERNAL SYMMETRIES. Landau, Lawrence J. (Hamburg Univ. (West Germany). Institut fuer Theoretische Physik (II)). Feb 1970. 29p. Dep. CFSTI (U. S. Sales Only).

Symmetries are investigated from the local viewpoint. Using the Haag–Ruelle construction, the action of a local internal symmetry on the asymptotic states is determined. A condition of "asymptotic locality" is derived and used to show that the symmetry acts linearly and locally on the asymptotic fields. Within a field theoretical framework it is shown that the internal symmetry must commute with the Poincaré group. The general structure of an internal symmetry is determined. The uniqueness of the representation of the Poincaré group is discussed, and a simple example of an infinite component field is given to indicate what occurs when there are infinitely degenerate particle multiplets. (auth)

28572 EXTENDED LIE SYSTEMS. II. Yasuda, Hiroshi (Hokkaido Univ. of Education, Japan). Tensor; 21: 117-23(Jan 1970).

Metric connections are introduced which can be considered as generalizations of the (+), (–), and (0) connections in semi-simple group manifolds. Conditions that the symmetric connections (+), (–), and (0) be Riemannian ones are given, and several Weyl connections are introduced which reduce to the Riemannian ones in semisimple group manifolds. Also normal projective connections are introduced which can be considered as generalizations of the fourth connections in group manifolds. A local n-uple Lie system $V_n\{\xi,\alpha\}$ is considered. (J.F.P.)

28573 RELATIVISTIC INTERACTIONS AND REDUCIBLE REPRESENTATIONS OF THE POINCARE GROUP. Biritz, H. (Georgia Inst. of Tech., Atlanta). Nuovo Cim.; 67A: 417-28 (1 Jun 1970).

The representations of the Poincaré group corresponding to elastic scattering of scalar particles (no bound states) are studied. These representations are unitarily equivalent to the one describing free particles. Not all such unitarily equivalent representations are of interest in physics. A simple lemma characterizing those representations which are physically acceptable, i.e., reproduce the standard results of formal scattering theory. (auth)

28574 A UNICITY THEOREM ON THE REALIZATIONS OF SEMI-SIMPLE LIE ALGEBRAS WITH QUANTUM CANONICAL VARIABLES. Simoni, A.; Zaccaria, F. (Syracuse Univ., N. Y.). Nuovo Cim.; 67A: 336-44(21 May 1970).

For all classical semi-simple Lie algebras a unicity theorem is given for canonical realizations with degree of freedom equal to the rank. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 28521, 28530, and 28785.

28575 (SU-1206-219) CP-VIOLATION IN THE NEUTRAL K SYSTEM. Yun, Suk Koo (Syracuse Univ., N. Y. Dept. of Physics). Jan 1970. 34p. (NYO-3399-219). Dep. CFSTI.

The theoretical aspects of CP violation are considered. The discussion covers the K_S and K_L states, unitarity relations, parametrization and analysis, the electric dipole moment of the neutron, η asymmetry and C noninvariance, and various theoretical models. (J.F.P.)

28576 ON POSSIBLE CHECK OF T INVARIANCE IN FOUR-LEPTONIC DECAYS OF K^4 MESONS. Safronov, A. N. (Moscow State Univ.). Yadern. Fiz.; 11: 641-7(Mar 1970). (In Russian)

Possible check of the T invariance in the processes $K^4 \rightarrow \mu^+\nu(\overline{\nu})e^+e^-$ due to weak and virtual electromagnetic interactions is discussed. The proposal is to search the T odd correlation con-

taining particle momenta only. This correlation may essentially affect the differential probability of the decay under consideration if the mechanism of the T violation is related to the photon emission. (auth)

28577 QUESTIONS RAISED BY CP-NONCONSERVATION. Kabir, P. K. (Rutherford High Energy Lab., Chilton, Eng.). Ergeb. Exakten Naturwiss.; 52: 91-112(1970).

The lectures are divided between phenomenological analysis of neutral kaon decays, and speculations concerning the unknown origin of CP-noninvariance. The first part deals with general considerations, which should be unaffected by changes in the experimental data. A simple model by Weinberg is considered; an analysis is then made of $K^0 \to 2\pi$ decays. Tests of T-invariance are discussed. The second part deals with various theories for the CP-noninvariance: superweak theories; milliweak theories, millistrong theories; and a theory based on the existence of new types of particles called a-particles. (L.B.S.)

28578 GRAPHICAL REPRESENTATION OF CP-NONCONSERVATION PARAMETERS IN K^0 DECAY. Ashkin, Julius (Oxford Univ.); Kabir, P. K. Phys. Rev., D; 1: 868-73(1 Feb 1970).

CP-nonconservation parameters in K^0 decay are plotted in a way which directly exhibits the conditions imposed by unitarity and TCP invariance. A similar construction shows the conditions under which the hypothesis of T invariance can be disproved. (auth)

28579 SYMMETRY BREAKING IN PHOTONIC MATRIX ELEMENTS AND THE WEAK VECTOR CURRENT. Kummer, W.; Schweda, M. (Institut fuer Hochenergiephysik, Vienna. Technische Hochschule, Vienna). Nuovo Cim.; 67A: 305-30 (21 May 1970).

An earlier suggestion of Majerotto and one of the authors (W. K.) to obtain relations for the electromagnetic symmetry-breaking in photonic matrix elements of the weak vector current is generalized to similar matrix elements of an arbitrary local operator. This has been achieved by a formulation of a zero-momentum theorem for an auxiliary quantity. The only assumption made, similar to the usual one in breaking the chiral symmetry, is that the algebra of charges of the internal symmetry group remains the same after breaking the symmetry electromagnetically. As an example this procedure is applied to the vector currents of weak radiative reactions like $\pi \to e\nu\gamma$, $\pi^+ \to \pi^0 e\nu\gamma$, and radiative μ-capture and it is found that requirements like gauge invariance and minimal electromagnetic coupling can be consistently incorporated. Because of the lack of sufficient experimental information concerning especially the last two aforementioned reactions, simple dispersion-theoretic models are used to show that the corrections from symmetry breaking are in general large entailing the complete breakdown of CVC in such matrix elements. At least in the kinematical range of the examples referred to above, however, the corrections are well determined by the soft-photon limit of the symmetry-breaking term. (auth)

Field Theories

General

28580 (IFVE-STF-69-19) LAMB SHIFT AND NONLINEAR ELECTRODYNAMICS. Arbuzov, B. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1969. 9p. (In Russian). Dep. CFSTI (U. S. Sales Only).

It is shown that the deviation of the measurements of the Lamb shift from the theory can be ascribed to the effect of the nonlinearity of the electrodynamics equations with the characteristic length being $l_0 \approx 1o\ 10^{-14}$ cm. (auth)

28581 (ITF-70-15) GAUGE INVARIANCE AND REGULARIZATION. Medvedev, B. V.; Pavlov, V. P.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 19p. (In Russian). (CONF-691035-7). Dep. CFSTI (U. S. Sales Only).

From Conference on High Energy Physics and Theory of Elementary Particles, Kiev, USSR.

It is shown that Pauli–Villars regularization, in which one needs to preserve the gauge invariance at all the stages of the perturbative calculations, has the unusual properties. The values of the convergent integrals of positive-definite functions as well as of divergent ones vanish under this regularization, and the discontinuities arise in the regular parts of divergent graphs. The physical sense of Pauli–Villars procedure and possibility of vanishing of divergent parts of all the graphs are discussed. (auth)

28582 (JINR-P2-4941) PRESENT STATUS OF NONLOCAL AND UNRENORMALIZABLE FIELD THEORY. Blokhintsev, D. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 20p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The present status of nonlocal and unrenormalizable field theory is reviewed in general on the basis of the works carried out at the Laboratory of Theoretical Physics (JINR). (auth)

28583 (JINR-P2-5021) ON A SIGN OF AN IMAGINARY PART OF QUASI-POTENTIAL. Bogolyubov, P. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

It is shown that in the expression for quasi-potential there appears a positive imaginary part. (auth)

28584 GENERALIZATION OF PLANE WAVE SOLUTIONS OF THE FIELD EQUATIONS OF NON-SYMMETRIC UNIFIED FIELD THEORIES OF EINSTEIN, SCHROEDINGER, AND BONNOR. Lal, K. B.; Ali, Najaf (Gorakhpur Univ., India. M.L.K. Degree Coll., Balrampur, India). Tensor; 21: 39-47(Jan 1970).

A space–time metric is considered. It is noted that the exact plane-wave solutions in the space–time defined by this metric of the field equations of Einstein and Bonner nonsymmetric unified field theories exist under certain conditions, while the solutions of the Schroedinger field equations do not exist. When the field is very weak the solutions of the Einstein and Bonner field equations become the same. (J.F.P.)

Quantum Field Theory

Refer also to abstracts 28515 and 28628.

28585 (ITF-70-16) ON THE HAMILTONIAN FORMULATION OF THE QUANTUM ELECTRODYNAMICS WITH GAUGE-NON-INVARIANT REGULARIZATION. Pavlov, V. P.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 9p. (In Russian). (CONF-691035-8). Dep. CFSTI (U. S. Sales Only).

From Conference on High Energy Physics and Theory of Elementary Particles, Kiev, USSR.

The interaction Hamiltonian in the interaction representation is constructed for quantum electrodynamics within the second order in charge in the gauge-noninvariant regularization case, when one needs to take into account the photon mass renormalization counter-term. It is shown, that one may not confine oneself to Wick theorem with only pair concentrations of the spinor fields in this case. There is an additional noncovariant term in the Hamiltonian, which corresponds to the difference between the Wick and Dyson τ-products of electromagnetic currents; this difference does not vanish under gauge-noninvariant regularization. (auth)

28586 (UCRL-19730) SPINORS FROM VECTORS. Garwin, C. (California Univ., Berkeley. Lawrence Radiation Lab.). 18 Mar 1970. Contract W-7405-eng-48. 14p. Dep. CFSTI.

Working in general at fixed time, spinor quantities are constructed out of vectors. The methods used are not directly applicable to dynamical fields. (auth)

28587 (UCSD-10-P-10-69) CAUSALITY AND LORENTZ INVARIANCE IN RELATIVISTIC QUANTUM MECHANICS. Ishikawa, Yoshiko (California Univ., La Jolla, San Diego. Dept. of Physics). Feb 1970. Contract AT(11-1)-Gen-10. 70p. Dep. CFSTI.

Thesis.

In the Fock space of the physical states of a single spinless particle, an attempt is made to construct an interaction Hamiltonian. The following conditions on the Hamiltonian are imposed. It is Hermitian. It does not affect the vacuum and single particle states. The S-matrix given by Dyson's formula is Lorentz-invariant. Any interaction Hamiltonian in field theory does not satisfy the second condition, since the Fock space of the theory consists of bare states instead of physical states. As it is the case in field theory, the Lorentz invariance of the S-matrix is possibly attained through an interaction Hamiltonian which can be expressed by the space integral of a causal and Lorentz invariant interaction Hamiltonian density. It is found, however, that an interaction Hamiltonian density in the physical Fock space, made of a sum of terms, each of which has finite number of creation and annihilation operators, ($a^\dagger_{k_1} \dots a^\dagger_{k_n} a_{k_{n+1}} \dots a_{k_m}$ with n finite) can probably not satisfy both Lorentz invariance and causality simultaneously. The question whether a meaningful Hamiltonian density, made of infinite series including terms with infinite number of creation and annihilation operators, can fulfill both the

conditions is open. Since the way described above is not a unique one to attain the invariance of S-matrix, other possibilities are sought. A fairly simple way is found to construct an interaction Hamiltonian without a causal and invariant density, which gives a Lorentz invariant S-matrix. It is even possible to obtain an interaction Hamiltonian which leads to exactly the same S-matrix as that given by field theory. The detail is investigated using the S-matrix given by the φ^4 model of scalar field theory. It is concluded that the properties of S-matrix (Lorentz invariance, analyticity, etc.) do not necessarily require causality and Lorentz invariance of an interaction Hamiltonian density. (auth)

28588 POSITIVITY OF ENERGY AND CONDITIONS ON FORM FACTORS IN INTERACTION LAGRANGIANS. Gromes, Dieter (Univ., Marburg, Ger.). Z. Phys.; 234: 112-19(1970).

It is shown that a conserved energy-momentum tensor for a system of classical fields with nonlocal interaction, as given in an ansatz by Pauli, exists, if and only if the field equations are derivable from a Lagrangian. In contrast to the total momentum four-vector the tensor is not unique. By means of a model of classical fields it is shown that form factors vanishing for large values in momentum space can lead to arbitrary large negative energies. This will greatly restrict the possibility of introducing nonlocal interactions. (auth)

28589 CONFIRMATION OF A NEW THEORETICAL VALUE FOR THE LAMB SHIFT. Lautrup, B. E.; Peterman, A.; De Rafael, E. (CERN, Geneva). Phys. Lett.; 31B: 577-9(27 Apr 1970).

We have performed a recalculation of the contribution to the Lamb shift from two fourth order vertex graphs. We agree with a recent calculation by Appelquist and Brodsky. (auth)

28590 PRIMITIVE GRAPHS OF DUAL-RESONANCE MODELS. Gross, D. J.; Neveu, A.; Scherk, J.; Schwarz, J. H. (Princeton Univ., N. J.). Contract AF-49(638)1545. Phys. Lett.; 31B: 592-4(27 Apr 1970).

It is shown that the problem of constructing and, if necessary, renormalizing general diagrams in dual-resonance models can be reduced to the study of only four primitive graphs, three of which are tadpoles, the last one being a self-energy graph. Consequences and applications of this reduction are discussed. (auth)

28591 PHYSICAL SYMMETRIES IN THE FRAMEWORK OF QUANTUM FIELD THEORY. Lopuszanski, Jan T. (Univ., Wroclaw). Ergeb. Exakten Naturwiss.; 52: 201-14(1970).

The general problem of exploring physical symmetries in a theory of several scalar, real fields is examined. By a physical symmetry is meant not only internal symmetries, preserving strict locality, but a possibly larger class of symmetries mapping localized elements of the field algebra into localized elements almost local with respect to the former. Only physical symmetries that commute with the Poincare group and with the TCP operator are considered. It is shown how to find the most general form of such a symmetry, provided it is unitarily implemented in the Hilbert space. For SU(2) symmetry the generalized Carruthers theorem is obtained. The case of bispinor fields is also considered. (L.B.S.)

28592 RELATIVISTIC TIME AND THE PRINCIPLE OF CARATHEODORY. Newburgh, R. G. (Air Force Cambridge Research Labs., Bedford, Mass.); Phipps, T. E. Jr. Nuovo Cim.; 67B: 84-102(11 May 1970).

Any formulation of the theory of relativity specifies implicitly or explicitly the exactness or inexactness of the temporal and spatial differentials which occur. In the Minkowski formulation one assumes implicitly the exactness of co-ordinate or common time and the inexactness of proper time. Several other possibilities are examined, especially that of the exactness of proper time and the inexactness of common time. With this assumption one is led to a space–proper-time (SPT) representation of events which yields the customary formal results of the theory including the differential ageing prediction of the "twin paradox," permits an analog of Fermat's principle to describe both particles and light, and leads to a many–proper-time formulation of the relativistic many-body problem essentially equivalent to the Minkowski space formulation. Analogies between this SPT geometry and the geometric approach to thermodynamics, especially as formulated by Carathéodory, suggest the γ-function of relativity is an integrating factor with physical meaning for the many-body problem and also provides insight into the concept of virtual photons. (auth)

28593 CONSTRAINTS IN ELECTRODYNAMICS AND QUANTIZATION OF THE ELECTROMAGNETIC FIELD WITHOUT CHARGES. Carmeli, M. (Aerospace Research Labs., Wright Patterson AFB, Ohio). Nuovo Cim.; 67B: 103-14(11 May 1970).

The degrees of freedom of the electromagnetic field are discussed. It is pointed out that a single complex function, which satisfies a two-dimensional wave function, can be defined to describe the dynamics of the Maxwell field. The canonical quantization procedure is then applied to quantize this wave equation for the case without charges. As a result, the electromagnetic field is effectively quantized, with the familiar problem of constraints becoming redundant in this simple case. (auth)

28594 FIELD PRODUCTS AT SHORT DISTANCES. de Mottoni, P.; Genz, H. (Univ., Hamburg). Nuovo Cim.; 67B: 1-12 (11 May 1970).

If the Wightman distributions of a real scalar field behave at short distances like powers of the distance, then the worst singularity in the product of an even number of field operators "at the same point" is carried by the vacuum expectation value. More generally, if there are logarithmic deviations from the powerlike behavior at small distances, the highest singularity of an even power of the field differs at most by logarithmic factors from the singularity of its vacuum expectation value. In the same limit, the singularities of the truncated Wightman distributions are discussed and compared to those of the untruncated ones. (auth)

28595 GROUP-THEORETICAL STRUCTURE OF FREE QUANTUM FIELDS IN TWO DIMENSIONS. Dubin, D. A. (Imperial Coll. of Science and Tech., London). Nuovo Cim.; 67B: 39-54(11 May 1970).

The Lorentz and Poincaré groups in two-dimensional space-time, isomorphic to R and $R \oplus R_1$, respectively, are discussed. The representations relevant for applications to physics are given. The complete equivalence between free local boson, respectively free local fermion Dirac fields and the direct sum of scalar fields, boson type respectively fermion type, is given. The tensorial approach to gravitation consistent with derivatives of $g^{\mu\nu}$ of order ≤ 2 is shown to require, ab initio, spaces of constant curvature. A simple plausible physical counterexample is given. (auth)

28596 QUASI-RENORMALIZABLE MODEL OF FIELD THEORY. Esposito, F.; Esposito, U. (CNR, Naples). Nuovo Cim.; 67A: 369-76(1 Jun 1970).

A model of field theory having characteristics "intermediate" between those of a renormalizable and of a nonrenormalizable one is studied. In this model, although the order of divergences increases with the power in the perturbative expansion, it is possible to collect all the divergent parts into a parameter b, which appears in the renormalized coupling constant $\bar{g} = g_0/(1 + bg_0(\partial/\partial\xi_0))$. Such a coupling constant can be interpreted as the sum of infinite counterterms to be added to the interaction Lagrangian. (auth)

28597 ON THE NOTION OF COMPOSITE PARTICLES IN QUANTUM THEORY OF FIELDS. Koutchouk, F. (Institut Henri Poincare, Paris). Nuovo Cim.; 67A: 483-96(1 Jun 1970). (In French).

By explicit diagonalization of the Hamiltonian of a two-fields model, the physical-fields operators are obtained, which satisfy the usual commutation or anticommutation relations in the whole Hilbert space H of the model when the coupling constant λ is non-negative. When λ is negative, only the physical boson field is an acceptable field operator, for a set of bound states appears which makes uncertain the definition of the physical operators to be associated to the fermion field. (auth)

28598 A DAUGHTER REGGE TRAJECTORY IN A FIELD-THEORY MODEL. III. Swift, A. R.; Tucker, R. W. (Univ. of Massachusetts, Amherst). Nuovo Cim.; 67A: 345-55(21 May 1970).

The second daughter Regge trajectory and the four satellite poles which accompany it in a perturbation-theory treatment of ladder diagrams are examined in detail. Although the second daughter pole couples to equal mass two-particle states, it is very slowly moving for $s > 0$ while the leading pole is rising rapidly towards the physical region. The daughters of the two satellite poles accompanying the first daughter trajectory are also qualitatively different from their parents. The conclusion is that even, as well as odd, daughter Regge trajectories are definitely not parallel to the parent trajectory and are unlikely ever to reach the physical region. (auth)

28599 RELATIVISTIC QUANTUM MECHANICS OF IDENTICAL BOSONS. Marx, E. (Drexel Univ., Philadelphia). Nuovo Cim.; 67A: 129-52(21 May 1970).

The probabilistic interpretation of the relativistic scattering of a charged scalar particle by an external electromagnetic field to a system of several such particles is described. It is found that the use of causal Green functions again demands the specification of

boundary conditions for particles at the initial time, and for antiparticles at the final time. The resulting theory is essentially one for a fixed number of particles, which can be found in two states, customarily described as "going forward in time" (particles) and "going backward in time" (antiparticles). This feature allows, and strongly recommends, the use of Dirac's many-time formalism, with one time parameter for each particle. The probabilistic interpretation includes the possibilities of pair creation and annihilation. (auth)

28600 NONUNIQUENESS OF SOLUTIONS IN QUANTUM FIELD THEORY. de Brucq, D.; Tirapegui, E. Nuovo Cim.; 67A: 225-46(21 May 1970).

The Hamiltonians of a class of models in quantum field theory are shown to be symmetric operators with deficiency index (1, 1). It follows that an infinite number of dynamical evolutions are possible. The connection between global methods of calculation and perturbation theory is studied for these models. (auth)

28601 COMMENTS ON A NEW EXPERIMENTAL TEST OF SPECIAL RELATIVITY. Ruderfer, M. (Dimensions, Inc., Hempstead, N. Y.). Lett. Nuovo Cim.; 3: 658-62(23 May 1970).

Various previous tests of special relativity theory are described together with the conclusions to be drawn from them. It is suggested that the Michalson–Morley experiment be repeated with the available improved techniques. (J.F.P.)

Gravitation and General Relativity

Refer also to abstracts 28058 and 28455.

28602 (AD-701726) RESEARCH PROGRAM IN THE THEORY OF ELEMENTARY PARTICLES. Arnowitt, R. (Syracuse Univ., N. Y.). Nov 1961. Contract AF33(616)-5598. 13p. (ARL-85). CFSTI.

A summary of the research performed is given which includes the following: Investigations of radiation and energy in classical general relativity. General invariant expressions for these quantities are discussed for spaces that become asymptotically flat sufficiently rapidly; Quantization of the Yang–Mills field. Rigorous quantizations in specific gauges are described as well as the general difficulties of quantizing nonlinear gauge type theories; Spinor techniques in relativity. The initial value problem on null surfaces for linearized gravitational theory and other Lorentz covariant theories are described; Extended electron models in classical electromagnetic theory. Possible directions for future research in these four fields are briefly mentioned. (auth)

28603 THE WAVE SOLUTIONS OF THE FIELD EQUATIONS OF EINSTEIN'S, BONNOR'S, AND SCHROEDINGER'S NON-SYMMETRIC UNIFIED FIELD THEORIES IN A GENERALIZED TAKENO SPACE–TIME. Lal, K. B.; Ali, Najaf (Gorakhpur Univ., India). Tensor; 21: 243-9(May 1970).

It is shown that the field equations of the nonsymmetric unified field theories of Einstein and Bonner yield wave solutions in the generalized Takeno space-time metric while the field equations of Schroedinger's theory do not give any wave solution in the same space-time. (L.B.S.)

28604 WAVE SOLUTIONS OF THE FIELD EQUATIONS OF GENERAL RELATIVITY IN A GENERALIZED TAKENO SPACE–TIME. Lal, K. B.; Ali, Najaf (Univ. of Gorakhpur, India). Tensor; 21: 134-7(May 1970).

The plane wave solution of the field equations of general relativity is obtained in a generalized Takeno space-time metric, considering only the postulate that the plane wave g_{ij} is a non-flat solution of the field equation. (L.B.S.)

28605 GROUPS, CONSERVATION LAWS, AND THE FORGOTTEN LAWS OF BALANCE. Edelen, D. G. B. (Lehigh Univ., Bethlehem, Pa.). Nuovo Cim.; 67B: 29-38(11 May 1970).

The ten laws of conservation of mass-energy, linear momentum, angular momentum, and motion of the center of mass of a continuous conservative system in Minkowski space can be derived either from the equations of motion, $\partial_A T^{AB} = 0$, or from the fact that Minkowski space admits the proper orthochronous Lorentz group as a group of motions. The system of ten laws of conservation is embedded in a system of fifteen laws of balance that derive from the conformal group of a Minkowski space. The derivations of laws of conservation and of laws of balance by use of the groups of isometries and of conformal motions in general relativity is shown to be a direct extension of the results that obtain in Minkowski space. Such laws admit equivalent representations in terms of integral laws, as opposed to $\nabla_A T^{AB}$. The nonconstant curvature of the space-time of general relativity is realized in terms of a loss of laws of conservation, although this need not be the case for laws of balance as shown by relativistic cosmology. The group of isometries of a space is embedded in the group of affine motions and this latter group of $p \leq 20$ parameters is shown to lead to a p-parameter family of symmetric fields T^{AB} such that $\nabla_A T^{AB} = 0$. Each element of this p-parameter family of covariant divergences then leads to laws of conservation and of balance by use of the groups of isometries and of conformal motions of the space. (auth)

28606 CONFORMAL CONCOMITANTS AND CONTINUITY EQUATIONS. du Plessis, J. C. (King's Coll., London). Contract AF 61(052)-877. Tensor; 21: 1-14(Jan 1970).

Conformal transformations for general relativity are treated. The general algebraic and differential properties of conformal tensor concomitants are discussed, and a class of divergence-free conformal tensors is constructed. (J.F.P.)

28607 SPINOR APPROACH TO SOME PROBLEMS IN LORENTZIAN GEOMETRY. Zund, J. D.; Maher, W. F. Jr. (Virginia Polytechnic Inst., Blacksburg). Tensor; 21: 70-4 (Jan 1970).

Some theorems in Lorentzian geometry are proven using van der Waerden spinors. The notation of two-component spinor calculus is introduced, and correspondences between tensors and spinors are recalled. Einstein manifolds are studied. A proof is given for the Ruse–Lanczos identity, and the Weyl projective spinor is introduced. The spinor formulation of the Lichnerowicz radiation conditions and the Zakharov theorem are presented. Conformally related Lorentzian manifolds are discussed. (J.F.P.)

28608 H SPACE–TIMES. Takeno, Hyoitiro; Kitamura, Shin-ichi (Hiroshima Univ. Fukui Univ., Japan). Tensor; 21: 83-8(Jan 1970).

An H space time for general relativistic field equation solutions in which both gravitational and electromagnetic plane waves coexist is discussed. This discussion includes conformally flat H's, the Debever–Penrose direction in an H, and Petrov and Synge classifications. (J.F.P.)

28609 SOME GLOBAL PROPERTIES OF SPHERICALLY SYMMETRIC SPACE–TIMES. Takeno, Hyoitiro; Kitamura, Shin-ichi (Hiroshima Univ. Fukui Univ., Japan). Tensor; 21: 89-94(Jan 1970).

Some global properties of spherically symmetric space–times are investigated. These space–times are easily obtained by the application of the Gauss–Bonnet theorem and the characteristic cohomology theory. Also the relation between a classification of spherically symmetric space–times is clarified. It is noted that a spherically symmetric space–time is a space–time which admits an isometry group isomorphic to the three-dimensional orthogonal group O(3). (J.F.P.)

28610 GENERALIZED KILLING VECTORS OF THE GROUPS OF GENERALIZED MOTIONS IN $X_4(I;G_\delta)$ AND $X_4(II;G_\delta)$. II. Abe, Shingo (Hiroshima Univ.). Tensor; 21: 101-16(Jan 1970).

The group of motions in the space–time with a nonsymmetric fundamental tensor are considered. All the generalized Killing vectors for $g_{\mu\nu}$ $(I;G_\delta)$ and $g_{\mu\nu}$ $(II;G_\delta)$ are obtained. (J.F.P.)

28611 GRAVITATIONAL FIELD OF A TACHYON. Peres, A. (Israel Inst. of Tech., Haifa). Phys. Lett.; 31A: 361-2 (6 Apr 1970).

A Schwarzschild field moving with superluminal velocity generates a wake of gravitational radiation which includes a Cerenkov shock-wave. (auth)

28612 SINGULARITIES IN GENERAL RELATIVITY. Pachner, J. (Univ. of Alberta, Edmonton). Can. J. Phys.; 48: 970-80 (15 Apr 1970).

The problem of singularities is examined from the standpoint of a local observer. A singularity is defined as a state with an infinite proper rest mass density. It is proved that any inhomogeneity and anisotropy in the distribution and motion of a non-rotating ideal fluid accelerates collapse. Collapse is also inevitable in a rotating fluid in the case of extremely high pressure when the relativistic limit of the equation of state must be applied. In order to investigate the influence of rotation on the existence of singularities in incoherent matter the Einstein equations together with their first integrals are written out for the points on a vortex filament. They show that rotation decelerates the contraction of space not only in the direction perpendicular to the vector of the angular velocity, but indirectly also along this vector and can prevent the occurrence of a singularity. This conclusion is confirmed by the numerical integration of the Einstein equations. A discussion of some cosmological implications is also given. (auth)

28613 GRAVITATIONAL FIELDS OF THE THIRD TYPE. Petrov, A. Z. JETP Lett. (USSR) (Engl. Transl.); 11: 141-2 (20 Feb 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 227-8 (20 Feb 1970).

Gravitational fields of the third type are discussed starting from the premise that Einstein's theory of gravitation is logically closed and requires no additional definition capable of excluding fields of the third type. A metric is found which defines a gravitational field of the third type. (J.F.P.)

28614 SPIN PRECESSION IN A "SCHWARZSCHILDIAN" FIELD. Voronov, N. A. Zh. Eksp. Theor. Fiz.; 58: 1280-2 (Apr 1970). (In Russian).

The spin precession velocity of a relativistic particle moving in the field of a point mass is calculated. The formula derived is a relativistic extension of the expression for the precession velocity of a classical gyroscope. It is shown that the quantity calculated is equal to the spin precession frequency in the reference frame obtained by a Lorentz transformation of the coordinate reference frame in an isotropic metric. (auth)

Scattering Theory

Refer also to abstract 28500.

28615 (ITF-70-7) LECTURES ON SCATTERING THEORY. 5. Sitenko, A. G. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 26p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The bases of the nonrelativistic theory of potential scattering are presented. Bound state scattering in the three particle system is considered. (auth)

28616 (ITF-70-8) LECTURES ON SCATTERING THEORY. 6. Sitenko, A. G. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 54p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The bases of the nonrelativistic theory of potential scattering are presented. Scattering of particles with spins and polarization phenomena in scattering are considered. (auth)

28617 OFF-SHELL EXTRAPOLATIONS OF THE VENEZIANO MODEL AND CURRENT ALGEBRA. Ellis, J. (Cambridge Univ., Eng.); Osborn, H. Phys. Lett.; 31B: 580-2(27 Apr 1970).

The extrapolation of the Veneziano amplitude by multiplicative factors is found to be inconsistent with aspects of current algebra. (auth)

28618 PHENOMENOLOGICAL IMPLICATIONS OF COLLIDING REGGE POLES AND CUTS. Ball, J. S.; Marchesini, G.; Zachariasen, F. (Univ. of Utah, Salt Lake City). Phys. Lett.; 31B: 583-8(27 Apr 1970).

It is suggested that Regge pole-cut combinations should, in the $t < 0$ region and until high energies are reached, always be parametrized simply by a complex conjugate pair of Regge poles, with no explicit contribution from the Regge cut. Effects of Regge cuts, at moderate energies, are well represented by complex pairs of poles. Some consequences of this suggestion are described. (auth)

28619 NON-PLANAR DUAL SYMMETRIC LOOP GRAPHS AND THE POMERON. Frye, G.; Susskind, L. (Yeshiva Univ., New York). Phys. Lett.; 31B: 589-91(27 Apr 1970).

Dual symmetric single loop graph amplitudes are constructed using the world sheet postulate and H. B. Nielsen's Lagrangian method. The result agrees with the sewing procedure of Bardakci, Halpern and Shapiro for planar loops and the prescription of Gallardo, Galli and Susskind for non-planar graphs. Non-planar loops possess a Pomeranchuk-like trajectory with slope $\frac{1}{2}\alpha'$ (0). (auth)

28620 COMPLEX POMERANCHUK TRAJECTORIES. Oehme, R. (Univ. of Chicago). Phys. Lett.; 31B: 573-6(27 Apr 1970).

Models for diffraction scattering are presented which contain complex Pomeranchuk trajectories and moving branch points of the type generated by these trajectories. Poles and cuts are correlated so as to remove unwanted branches of the pole surfaces from the physical sheet. (auth)

28621 FERMION REGGE POLES AND BRANCH POINTS IN J PLANE. Gribov, V. N.; Levin, E. M.; Migdal, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 11: 673-87(Mar 1970). (In Russian).

Mechanism of arising, positions and main properties of the branch points in the complex angular momentum plane that are related to the fermion Regge poles are discussed. Supplementary singularities behaving like $\sqrt{u}$ at $u \to 0$ arise due to interaction of fermion reggeons with the vacuum reggeons ("enhanced graphs"). The general situation with the singularities has two scales: $\sqrt{u}$ along the imaginary axis and u along the real axis. This corresponds to two diffraction radii in the scattering amplitude: $R_1 \sim \ln s$ and $R_2 \sim (\ln s)^{\frac{1}{2}}$. Two possible solutions for the scattering amplitude (the so called strong and weak couplings) are investigated at asymptotically high energies, $\ln \ln s \gg 1$. Angular distribution in case of weak coupling is considered in conclusion. (auth)

28622 MOMENTUM TRANSFER ANALYTICAL PROPERTIES OF SCATTERING AMPLITUDE IN QUASIPOTENTIAL APPROACH FOR GAUSSIAN POTENTIAL. Mestvirishvili, M. A.; Rcheulishvili, G. L. (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 11: 688-91(Mar 1970). (In Russian).

On basis of the quasipotential equation analytical properties of the scattering amplitude are studied for the Gaussian potential. The amplitude at physical s values is shown to be an entire function in the $\cos\vartheta$ plane. It is shown also that the amplitude has an essential singularity at a fixed complex $\cos\vartheta$ and $s \to \infty$. (auth)

28623 BACKWARD DIFFRACTION SCATTERING. Gubkin, I. A. (Leningrad State Univ.). Yadern. Fiz.; 11: 598-600 (Mar 1970). (In Russian).

A model representation of the scattering coefficient as a function of angular momentum is proposed. The representation makes it possible to describe the diffraction structure of the elastic scattering differential cross section at angles close to π. (auth)

28624 MULTIPLE SCATTERING MATRIX WITH ENERGY LOSSES. Manyukov, B. A.; Shlyapnikov, P. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 605-7 (Mar 1970). (In Russian).

A multiple scattering matrix which takes into account energy losses of the particle is obtained within the validity of the Fermi distribution. (auth)

28625 THEORY OF MULTIPLE SCATTERING. Gurvich, L. G.; Yarkulov, U. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 4, 57-9(1969). (In Russian).

Several relativistic and nonrelativistic theories of single and multiple scattering have been developed. Multiple scattering takes place at high collision parameters, at which the effect of external electrons should be taken into account. An expression was derived on the basis of the Hartree model; it contained a formula for the distribution function of particles which passed through a certain thickness of the material and were deflected under various angles. In order to evaluate the results of the calculation, the theoretical prediction of the new and earlier theories were compared with experimental data on Be and Au of other authors. It was found that the values derived from the multiple scattering theory of G. Z. Moliere agreed better with experimental data if the atomic potential is selected on the basis of the Hartree model. (TTT)

28626 SCATTERING BY NONPHYSICAL POTENTIALS: ANALYTICITY IN COUPLING CONSTANT. Lomsadze, Yu. M. (Uzhgorod State Univ., USSR). Ukr. Fiz. Zh.; 15: 237-44(Feb 1970). (In Russian).

A general method for investigating the nonrelativistic scattering by arbitrary "nonphysical" potentials $\lambda V(r) > 0(r^{-2})$ with $r \to 0$ is given reducing the problem of calculating the partial wave scattering amplitude to solving the inhomogeneous Volterra equation which is iterable an arbitrary number of times. The efficiency of the method is illustrated when studying the analytical properties of the amplitude with respect to various variables and, in particular, with respect to the variable λ which is the "interaction intensity." In spite of the scattering by "physical" potentials $\lambda V(r) \leq 0(r^{-2})$ with $r \to 0$ the scattering amplitude for "nonphysical" potentials inevitably possesses both an immovable singularity at the point $\lambda = 0$ and essential singularity in the s-plane at infinity. (auth)

28627 DYNAMICAL MODEL OF DUAL AMPLITUDES. Sakita, B.; Virasoro, M. A. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev. Lett.; 24: 1146-9(18 May 1970).

Nielsen's interpretation of the Veneziano amplitudes is reexamined from the point of view of the functional formulation. It is shown that the sum of a large number of "fishnet" Feynman graphs of very high order can be approximated by generalized Veneziano amplitudes. (auth)

28628 CAUSALITY AND SCATTERING OF WAVE PACKETS. Khalfin, L. A. (Steklov Mathematics Inst., Leningrad). JETP Lett. (USSR)(Engl. Transl.); 11: 28-30(5 Jan 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu; 11: 46-9(5 Jan 1970).

Causality is considered within the framework of the theory with a pseudo-Hermitian Hamiltonian. The space–time description of the scattering of wave packets is discussed, and restriction is made to elastic scattering in the s-state in the relativistic region. It is found that causality is violated, and that this violation takes place only when account is taken of the transformation of certain particles into others. (J.F.P.)

28629 A GENERAL APPROACH TO THE SYMMETRY AND THE FACTORIZATION PROPERTIES OF THE N-POINT DUAL AMPLITUDES. Chiu, C. B.; Matsuda, S.; Rebbi, C. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Nuovo Cim.; 67A: 437-73(1 Jun 1970).

A general method is presented for analyzing the consequence of the symmetries in the dual amplitudes. It is shown that the existence of the generalized gauge transformation is related not only to the reflection symmetry but also to the cyclic symmetry of the dual amplitudes. The explicit form is given for the generator of the gauge transformation in two different formalisms for the N-point function. Other transformation operators present in these formalisms are also investigated. (auth)

28630 TWO-PARTICLE RESONANCE-POLE DOMINANCE APPROXIMATIONS IN THREE-PARTICLE SCATTERING. Bolle, D. (Univ. of Louvain, Belgium); Kowalski, K. L. Nuovo Cim.; 67A: 523-37(1 Jun 1970).

Some of the conventional justifications for the two-particle resonance-pole dominance approximations in three-particle calculations are re-examined and found defective. It is also seen, on the basis of some simple model calculations, that the sharpness of a resonance is not necessarily a reliable indicator of the dominance of the off-shell amplitude by the resonance, even for parametric energies in its neighborhood. The physical implications and consequences of resonance-pole dominance are discussed. (auth)

28631 FURTHER REMARKS ON THE HIGH-ENERGY BEHAVIOR OF RESONANCE POLES IN THE COMPLEX PLANE. Paciello, M. L. (Univ., Rome); Taglienti, B.; Sertorio, L. Contract f 61 05267 C 0084. Nuovo Cim.; 67A: 553-73(1 Jun 1970).

By using a model unitarity dynamical scheme various possible energy behaviors of the resonance widths at high energy are analyzed. Correspondingly Re $\alpha(s)$ is calculated. Moreover in this model it is also found that a linear trajectory may only result in the limit of vanishing pion mass. (auth)

28632 GENERAL N-POINT VERTEX IN A DUAL MODEL. Kosterlitz, J. M.; Wray, D. A. (Univ., Turin). Lett. Nuovo Cim.; 3: 491-7(11 Apr 1970).

A previous procedure is extended to obtain a compact expression for the vertex function coupling an arbitrary number of resonances. This expression contains previous results as special cases. The result may be written in a form which shows the cyclic symmetry and hence the duality properties of the vertex. (J.F.P.)

28633 SCATTERING THEORY. NEW METHODS AND PROBLEMS IN ATOMIC, NUCLEAR, AND PARTICLE PHYSICS. Barut, A. O. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969). 437p.

The book included 11 chapters. Separate abstracts were prepared for each chapter. (J.F.P.)

For abstracts of individual chapters see: 28113, 28114, 28501, 28547, 28634–28639, and 28855.

28634 VARIABLE-PHASE APPROACH TO POTENTIAL SCATTERING. Calogero, F. (Univ., Rome). pp 3-46 of Scattering Theory. /Barut, A. O. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The essential features of the variable phase method for evaluating scattering phase shifts are reviewed and bound states are discussed. The presentation gives the basic philosophy of this approach and its convenience. The derivation of the phase equation, approximate and variational solutions, low-energy expansion, the Dirac equation, complex potentials, multichannel potentials, and bound states are considered. (J.F.P.)

28635 EXACT RELATIONSHIPS BETWEEN THE POTENTIAL AND THE SCATTERING DATA. Degasperis, A. (Univ., Rome). pp 53-61 of Scattering Theory. /Barut, A. O. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The main results previously obtained on potential scattering theory are summarized. A nonrelativistic S-wave scattering caused by an interaction Hamiltonian described by a function V(r) such that the Taylor expansion holds for every $r \geq 0$ is considered. (J.F.P.)

28636 UPPER AND LOWER LIMITS FOR THE NUMBER OF BOUND STATES OF PHYSICAL SYSTEMS. Ghirardi, G. C. (Univ., Trieste, Italy). pp 65-84 of Scattering Theory. /Barut, A. O. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The derivation of upper bounds to the number of eigenvalues of a given Hamiltonian which lie below an assigned energy value is treated. The results are relevant to scattering theory as well as to bound-state problems. Previous methods are discussed including their application to the Bethe–Salpeter equation. (auth)

28637 MANY-CHANNEL COLLISION THEORY, THRESHOLD CUSPS, AND RESONANCE PHENOMENA. Fonda, L. (Univ., Trieste, Italy). pp 129-90 of Scattering Theory. /Barut, A. O. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

Quantum mechanical collision theory is reviewed. A rigorous definition of scattering amplitudes, cross sections, and the S-matrix is given. Those anomalies which appear as a function of energy in the cross section at the threshold of a new reaction channel are discussed in detail. These are the Wigner cusps. Various physical implications of these threshold effects are considered. The resonance mechanism is also discussed, and the complex potential model and the decay law of the resonant states are considered. (J.F.P.)

28638 ANALYTIC SCATTERING MATRIX AND ALGEBRAIC THEORY OF SCATTERING. Barut, A. O. (Univ. of Colorado, Boulder). pp 341-74 of Scattering Theory. /Barut, A. O. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

Methods and problems for the scattering of fundamental particles are considered. The phenomena studied are all in the relativistic region because the excitation energies are of the order of or larger than the rest energies. Relativistic invariance, internal structure, elementary and composite scatterers, strongly interacting particles, and a summary of the experimental results are discussed. Also analytical scattering theory is treated including the framework and general procedure, quantum electrodynamics, and the S-matrix theory of hadrons. Algebraic scattering matrix theory is likewise discussed. (J.F.P.)

28639 VERY-HIGH-ENERGY PARTICLE SCATTERING. Morel, A. (Centre d'Etudes Nucleaires, Saclay, France). pp 375-431 of Scattering Theory. /Barut, A. O. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

A review of very high energy scattering is presented. This review covers the general features of all existing experiment data at high energy to find meaningful parameters for the physical quantities. The theorems which are obtained in the framework of analyticity, crossing, and unitarity are discussed, and their content is compared with experimental results. Also a review of various Regge pole models is given. (J.F.P.)

Particle Accelerators

Refer also to abstracts 27101, 27102, 27237, 27390, 27401, 27410, 28257, 28746, and 28769.

28640 (CERN-Trans-69-22) APPARATUS FOR MEASUREMENT OF THE FREQUENCY OF BETATRON OSCILLATIONS OF THE 70-GeV ACCELERATOR BEAM. Uvarov, V. A. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated by A. Golovanoff (CERN, Geneva, Switzerland), from report NTD-6826. 9p. (In French). Dep. CFSTI (U. S. Sales Only).

A system for the rapid measurement of the frequency of betatron oscillations for the 70-GeV accelerator at IFVE is described. The system is based on the principle of the measurement of the period of excited coherent oscillations in fractions of the revolution period of the particles. The system permits a measurement of ΔQ with a precision of ~10% for a beam deflection of 2 mm at the intensity of 10^{10} p/p and 0.2 mm at 10^{11}. (J.S.R.)

28641 (CERN-Trans-69-24) RADIO-FREQUENCY CONTROL SYSTEM FOR THE BEAM OF THE 70-GeV PROTON SYNCHROTRON. Ivanov, Yu. S.; Kalinin, V. A.; Kuz'min, A. A.; Chirkov, S. V. (Akademiya Nauk SSSR, Moscow. Radiotekhnicheskii Institut). Translated by A. Golovanoff (CERN, Geneva, Switzerland), from report NTD-6823. 11p. (In French). Dep. CFSTI (U. S. Sales Only).

The system for the control of the radiofrequency by use of the beam is based on the regulation of the frequency of the pilot generator by signals proportional to the radial displacement of the beam with respect to the nominal orbit and proportional to the dephasing of the center of gravity of the beam with respect to the

accelerator field. The control system is described and its operational efficiency is discussed. (J.S.R.)

28642 (CONF-690540–, pp 76-86) RADIOINDUCED ACTIVITY IN AIR IN HIGH-ENERGY ACCELERATOR INSTALLATIONS. Hoefert, M. (European Organization for Nuclear Research, Geneva (Switzerland)). (In German).

High-energy accelerators induce radioactivity in the surrounding air as well as in the walls and shielding material. Under more realistic conditions than previously employed, activities were recalculated for ^{41}Ar, ^{15}O, ^{11}C, and ^{13}N. Results obtained with the new method showed higher values than expected. The critical organ for these radioisotopes is the skin. From the standpoint of radiation burden to personnel, γ radiation emitted by isotopes produced in structural elements and shielding material exceeded that induced in air by several orders of magnitude. It was concluded that, for the CERN accelerator, radioactivity induced in the air is negligible as potential radiation hazard. (H.B.G.)

28643 (CONF-690540–, pp 596-604) DOSE RATE MEASUREMENTS IN THE ACCELERATION OF HEAVY IONS WITH TANDEM VAN DE GRAAFF ACCELERATORS. Festag, J. G. (Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany)). (In German).

Dose rate measurements were performed at a concrete-shielded measuring station 3 m distant from the target of a Van de Graaff accelerator. The accelerated ions consisted of ^{7}Li, ^{12}C, ^{16}O, ^{19}F, and ^{32}S. With increasing atomic number the dose rate decreased from 200 mrem/hour for ^{7}Li to 0.2 mrem/hour for ^{32}S. To decrease the dose rate, a tantalum window was used to prevent the primary beam from hitting brass and aluminum parts of the apparatus. (H.B.G.)

28644 (JINR–P9-5033) ORBIT PARAMETERS OF THE 2-METER JINR ISOCHRONOUS CYCLOTRON. Shelaev, I. A.; Kozlov, S. I.; Klenin, B. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1970. 18p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The scheme of the calculation of the orbit parameters and phase graphs, adopted by processing the data of the magnetic field measurements of the 2-metre isochronous cyclotron, is described. The results of this calculation performed by use of the BESM-4 computer are presented. It is shown that the values of the ν_z, ν_r betatron oscillation frequences, obtained according to the approximate analytical formulae, agree well with the results of numerical integration. (auth)

28645 (JINR–P9-5037) EXPERIMENT ON THE BEAM EXTRACTION BY AN ELECTROSTATIC DEFLECTOR FROM THE JINR 2-METRE ISOCHRONOUS CYCLOTRON. Shelaev, I. A.; Alfeev, V. S.; Kozlov, S. I.; Nikolaev, V. M.; Oganesyan, R. Ts. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1970. 12p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Extraction of the ion beam from the JINR 2-meter isochronous cyclotron by a system combining an electrostatic deflector and focusing magnetic channel is described. (auth)

28646 (N–70-17605) A PROPOSED METHOD FOR REGENERATION OF NEUTRON PRODUCING TARGETS, WITHIN AN ACCELERATOR, BY ION SPUTTERING TECHNIQUES. Alger, Donald L.; Steinberg, Robert (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan 1970. 24p. (NASA-TN-D-5598; E-5073). CFSTI.

A proposed sputtering electrode system design is presented that makes possible regeneration of targets within an accelerator. The formation of a tritide target from an applied titanium film is also discussed. The design of an X-ray fluorescence detector for measuring the thickness of material deposited or removed from the target is suggested. Finally, titanium and titanium deuteride etch rates are presented as obtained by a sputter electrode system mockup for a rotating target assembly under development. (auth) (USGRDR)

28647 (NP–18223) MEETING ON CONVERSION OF A MISSING MAGNET MACHINE TO A PARTLY SUPERCONDUCTING SYNCHROTRON. Arendt, F.; Erb, J.; Schauer, W.; Wuertz, W. (comps.) (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Nov 1969. 22p. Dep. CFSTI (U. S. Sales Only).

Discussions at the meeting held at Karlsruhe to consider problems in the conversion of a high-energy, missing-magnet proton-synchrotron to a partly superconducting one are presented. In this conversion, magnet-free spaces of the synchrotron lattice are filled with superconducting dipoles. Topics include considerations on the lattice with respect to conversion and extraction, attainable field accuracy and reproducibility, stored energy, magnetic shielding and eddy currents, vacuum and refrigeration systems and radiation damage. Also, a review of actual and future activities in different laboratories is given. (auth)

28648 (NP–18225) SOME RESULTS OF COMPUTATIONS CONCERNING THE INFLUENCE OF BENDING FIELD ERRORS ON RESONANT EXTRACTION. Erb, J.; Merle, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Mar 1970. 13p. Dep. CFSTI (U. S. Sales Only).

A brief description of a computer program which simulates approximately the behavior of particles in a synchrotron having nonlinear elements is presented. Some results and conclusions concerning the tolerable limit for the field error for resonant extraction are discussed. (W.H.K.)

28649 (NP–18231) IS THE ELECTRON RING ACCELERATOR (ERA) USEFUL FOR THE ACCELERATION OF HEAVY IONS? Schopper, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Oct. 1969. 8p. Dep. CFSTI (U. S. Sales Only).

The physical parameters and capabilities of the electron-ring accelerator for heavy-ion acceleration are briefly discussed. The energy–intensity relation, energy spread, and length of the accelerator are considered. (W.H.K.)

28650 (UCRL–19447) THE BERKELEY SYNCHROCYCLOTRON IMPROVEMENT PROGRAM. Kanstein, L.; Sorensen, R.; Glasgow, L.; Vale, J.; MacKenzie, K. (California Univ., Berkeley. Lawrence Radiation Lab.). Sep 1969. Contract W-7405-eng-48. 22p. (CONF-690921–4). Dep. CFSTI.

From International Cyclotron Conference, Oxford, England.

Studies to improve the 184 inch Berkeley synchrocyclotron have led to a design for a new RF system providing higher dee voltage and repetition rate. The one-half scale model is described along with a brief description of a model high power broadband beam stretching cee. (auth)

28651 ATTENUATION OF BREMSSTRAHLUNG GENERATED AT CONSTANT MEDIUM POTENTIALS. Soole, B. W.; Jager, W. F. (Admiralty Research Lab., Teddington, Eng.). Phys. Med. Biol.; 15: 107-16(Jan 1970).

The attenuation of the intensity and the exposure-rate of bremsstrahlung generated at constant potentials were calculated assuming that the spectral distribution of the radiation at the target is given by the Kulenkampff–Kramers relation, and that attenuation coefficients may be represented with sufficient accuracy by expressions of the form $C\lambda^3 + \sigma$. Values of C and σ were computed from published data for a large number of photon energy intervals. Results for the exposure-rate are compared with published experimental data for narrow beams generated at tungsten targets by potentials below 69.5 kv. Good agreement is obtained for those cases where the initial filtration is sufficient to remove target L-radiation and the beam is uncontaminated by fluorescence radiation from the filter. This close agreement indicates that the results presented for the attenuation of the radiation intensity, which have been computed in an analogous manner, are also correct under the same conditions. (auth)

28652 SACLAY ELECTRON LINEAR ACCELERATOR OF HIGH INTENSITY AND HIGH EFFECTIVE CYCLE. Netter, Francis (CEA, Saclay, France). Ind. At.; 14: No. 1-2, 21-33 (1970). (In French).

The Saclay electron linear accelerator passed the final tests conducted by the C.S.F. at the end of 1968. It is now in regular operation, producing beams of electrons and positrons in pulses of 10 microseconds at repetition rates of 1 and 2 kHz. The maximum energy of the electrons at zero current is 640 MeV at 1% of the effective cycle and 450 MeV at 2% of the effective cycle. At the effective cycle of 1%, and at 540 MeV, the peak current can reach 40 mA, the full width at half maximum of the energy spectrum being 3 or 4 per thousand. Numerous tests performed during 24 hours and longer, showed that the energy stability is higher than 1% per 24 hours. Beams of positrons with an average current of 0.1 to 0.2 microamperes are accelerated up to nearly 500 MeV. The first experiments are now under way. (France)

28653 MONTE CARLO CALCULATION OF THE SLOWDOWN OF AN ELECTRON BEAM IN A THICK TARGET OF LEAD. Knizhnikov, Yu. N. At. Energ. (USSR); 27: 463-8(Nov 1969). (In Russian).

First the probability of bremsstrahlung emission was calculated for passage of an electron with energy E_0 through a layer of substance Δt. Then the probable energy of the emitted quantum is calculated. Calculations were also carried out on the number of electrons of various energies, positron pairs, photon quanta and Compton electrons that are formed on passage of a 26 Mev elec-

tron through 0.25, 0.50, and 0.75 cm lead. The total thickness is subdivided into 30 subsections. A total of 10,000 events are analyzed. A deformation in the electron spectrum with increasing thickness can be seen. The average energy $\bar{E}$ is given for each thickness. The results of the calculations have also been repeated for 60 MeV electrons in 0.5 and 1.0 cm lead. (TTT)

28654 ANGULAR DISTRIBUTION OF BREMSSTRAHLUNG RADIATION FROM THICK TARGETS AT LOW ENERGIES. Tsipenyuk, Yu. M. At. Energ. (USSR); 27: 468-70(Nov 1969). (In Russian).

The angular distribution of bremsstrahlung radiation from impingement of 6.3 and 8.8 MeV electrons on thick tungsten targets 1.0 and 0.11 mm thick (0.3 and 0.03 radiation lengths respectively) was determined by counting at various positions with a movable thimble chamber having a gaseous volume of 2.1 cm^3. The chamber wall was covered with lead 3 mm thick to increase the sensitivity. Background corrections were carried out by taking differential readings with and without lead shielding. Theoretical calculations of the angular radiation distribution were carried out, and compared with experimental results obtained by measuring fission tracks in glass due to the photofission of ^{238}U with a threshold of 5.6 Mev. The divergence of calculated results from the experimental values was greater for the thicker target than for the thin target. Ionization losses in the thicker target lead to a decrease in the fraction of high-energy gamma quanta compared to a low-energy quanta. (TTT).

28655 APPARATUS FOR IRRADIATION OF PELLETS BY A HORIZONTAL BEAM OF CHARGED PARTICLES. Eremin, L. P.; Oblivantsev, A. N. (Tomsk Polytechnical Inst., USSR). Prib. Tekh. Eksp.; No. 6, 24-5(Nov-Dec 1969). (In Russian).

The apparatus with remote control for irradiation on the cyclotron of pellet preparations by the horizontal proton beam at temperatures of 25 to 300°C was described. The construction and operation of the apparatus excludes the postirradiation annealing of the dissociation products. (tr-auth)

28656 ACCELERATION OF LITHIUM IONS IN A CYCLOTRON. Vasil'ev, P. I.; Venikov, N. I.; Zevyakin, D. V.; Oglobiin, A. A.; Khaldin, N. N.; Khoroshavin, B. I.; Chuev, V. I.; Chumakov, N. I. (Inst. of Atomic Energy, Moscow). Prib. Tekh. Eksp.; No. 6, 16-18(Nov-Dec 1969). (In Russian).

An intense source of Li ions was created using an arc discharge in Li vapor. In the external beam of the 1.5 m cyclotron of the Inst. of Atomic Energy, $^6Li^{2+}$ and $^7Li^{2+}$ ions up to 8 μA with energies to 36 MeV and Li^{3+} ions up to 0.1 μA with energies to 60 MeV were obtained. Nuclear reaction processes with Li ions were studied. (tr-auth)

28657 CONVERSION OF THE ITEP PROTON SYNCHROTRON BY WORK ON THE 25-MeV LINAC INJECTOR. Barabash, L. Z.; Batalin, V. A.; Veselov, M. A.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp.; No. 6, 14-16(Nov-Dec 1969). (In Russian).

The parameters of the beam from the linear accelerator—the new injector for the ITEP proton synchrotron—are discussed. The injection system is described, and the process of adjusting the system is outlined. The conversion of the synchrotron by work on the linac increased the proton beam intensity from (1 to 1.5) × 10^{11} to (4 to 6) × 10^{11} protons/pulse. (tr-auth)

28658 OUTPUT FROM VACUUM OF A BEAM OF ACCELERATED ELECTRONS. Abramyan, E. A.; Chertok, I. L. Prib. Tekh. Eksp.; No. 6, 164-5(Nov-Dec 1969). (In Russian).

Test results are given for an apparatus with a rotated foil intended for the output from vacuum of a beam of electrons. Maximum parameters for the beam are 2.2 MeV and average power 20 kV. The diameter of the beam on the foil is ~5 mm. (tr-auth)

28659 PULSED GAS TARGET FOR RECORDING NEUTRAL ATOMS. Sorokin, A. F.; Tsel'nik, F. A. Prib. Tekh. Eksp.; No. 6, 26-7(Nov-Dec 1969). (In Russian).

The characteristics of the target created by pulsing gas into the charge exchange chamber for the transformation of neutral particles to ions are described. The time of propagation of the gas in the chamber constitutes tens of milliseconds. During this time the effective thickness of the target is not changed, and the gas constituting the material of the target does not enter the volume with the plasma. The proposed method permits targets of optimum thickness of any gas and removes the necessity of their individual calibration. (tr-auth)

28660 PRODUCTION OF THIN TARGETS WITH LARGE SURFACE AREA. Tomikova, I. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp.; No. 6, 202-4(Nov-Dec 1969). (In Russian).

Two methods for obtaining thin targets with large surface area on metal substrates are outlined. The mechanical method produces layers of Sm, Nd, Eu, Zn, Mo, Te, and their separated isotopes with thicknesses from 500 $\mu g/cm^2$ up to 7 mg/cm^2. The electrolytic method is used to obtain targets of Ru and Os on copper substrates with thicknesses of 1 to 3 mg/cm^2. (tr-auth)

28661 STRENGTH OF NICKEL FOILS. Robinson, D. C. (Univ. of Auckland, N. Z.). J. Phys., E (London); 3: 408-9 (May 1970).

The strength of nickel foils for use as windows in gas target cells, ranging in thickness from 0.51 to 1.27 μm, was measured. For apertures in the range 0.318 to 0.794 cm the pressure necessary to burst a foil was found to be $p = 2.299 \times 10^3(t - 0.31)/d^{1.27}$ kN m^{-2} where t and d are respectively the thickness (in micrometres) and the diameter (in centimetres) of the foil. (auth) (UK)

28662 300 GeV PROJECT LATEST DESIGN THINKING. CERN Cour.; 10: 107-11(Apr 1970).

The proposals for the CERN 300-GeV synchrotron project are discussed, and the advantages and disadvantages of each are described. The three possibilities include a fixed energy machine; an extendible "missing power" machine which has magnets capable of higher-energy operation but temporarily uses more economic and smaller power supplies; and an extendible energy "missing magnet" machine, which leaves space around the machine circumference where more magnets can be slotted in for higher energies when the money is available. The "missing magnet" design using separated-function magnets is currently favored. This concept anticipates the development of superconducting magnets so that the machine could possibly be extendible to 800 GeV or more. The cost, time element, and possibility for future development are compared for the different proposals. (W.H.K.)

28663 INDUCED RADIOACTIVITY AT CERN. Barbier, M. CERN Cour.; 10: 11-13(Jan 1970).

A brief description of some of the problems and some of the advantages of induced radioactivity around high-energy accelerators is given. (W.H.K.)

28664 ON HIGH-DUTY-FACTOR EXPERIMENTS AT THE TORINO 100-MeV SYNCHROTRON. Costa, S.; Ferrero, L. (Uni., Turin). Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 103: 663-71(Jul-Oct 1969).

The way in which a high utilization factor (2.5×10^{-2}) of the 100-MeV synchrotron of Torino can be obtained is described. In such conditions, the electromagnetic radiation pulse lasts 500 μsec and the photon spectrum of the beam is far removed from the usual Schiff spectrum integrated on the angles. A method is indicated to obtain the true spectrum of the bremsstrahlung radiation. The method is controlled by means of a direct measurement of the photon spectrum. This measurement is done by a scintillation spectrometer in coincidence. The knowledge of the photon spectrum really used is essential in order to obtain photonuclear cross sections with good resolution. (tr-auth)

28665 SOME RESULTS OF COMPLEX TUNING AND START-UP OF THE IHEP 70 GeV PROTON SYNCHROTRON. Ado, Yu. M.; Zhuravlev, A. A.; Logunov, A. A.; (and others). (Inst. of Theoretical and Experimental Physics, Moscow). At. Energ. (USSR); 28: 132-8(Feb 1970). (In Russian).

The process and character of works on complex tuning and start-up of the accelerator are described. Features and methods of tuning of the main accelerator systems are briefly discussed (ring electromagnet, power supply system, correction system, injection system, vacuum system, and radiotechnical systems). The main results obtained during the accelerator tuning are reported. (auth)

28666 4π-PRECISION VACUUM SCATTERING CHAMBER FOR THREE-BODY REACTIONS. Durisch, J. E.; Neumann, W.; Rossel, J. (Univ., Neuchatel, Switzerland). Nucl. Instrum. Methods; 80: 1-12(1970).

A high precision scattering chamber of spherical shape is described. It has an inside diameter of 120 cm, its volume is evacuated to 10^{-6} torr and has been specially designed for the study of three-body nuclear reactions. Special care has been given to the systems of remote control and of the spacial positioning of the three independently movable detector-telescopes of cooled silicon junctions, to the target-holder and to the system for the in situ evaporation of thin targets, to the storage of them, to the handling into the target-holder and to their protection against contamination by water-vapor and carbohydrides. A detailed description is given of all operations and of the procedures

chosen to align the scattering chamber. The whole equipment is presently used at the isochronous cyclotron of Grenoble in France. (auth)

28667 CALIBRATION OF A WILSON-TYPE QUANTAMETER. Dougan, P. (Univ. of Lund, Sweden); Stiefler, W.; Stein, H.; Wedemeyer, R. Nucl. Instrum. Methods; 80: 175-6(1970).

We describe the results obtained in calibrating a Wilson-type quantameter built at Lund at the Bonn 500 MeV and 2.5 GeV electron synchrotrons. (auth)

28668 THEORETICAL STUDY OF THE ENERGY DISPERSION OF ELECTRONS INJECTED IN A SUPERCONDUCTING LINEAR ACCELERATOR FUNCTIONING IN THE CONTINUOUS REGIME. Boussoukaya, M.; Septier, A. (Faculte des Sciences, Orsay, France). Nucl. Instrum. Methods; 80: 109-21(1970). (In French).

An analytical solution is given to the equations of motion of the electrons in a short traveling wave linac (output energy 5 MeV), in which very short bunches are injected. This solution is used to determine the optimum injection phase ϕ_T giving a minimum energy spread. Numerical integration of these equations for the same structure, working either with T. W., or with S. W., shows that the energy difference is small in a very narrow domain of injection phase $\Delta\phi_0$, but becomes important for particles injected far from ϕ_T. In S. W. linac energy dispersion and phase spread are smaller than in T. W. linacs. Taking into account electrons moving out of the axis, it is shown that injected beams of diameter smaller than 2 mm are necessary for obtaining an energy spectrum width less than 10^{-3}. In our case, space-harmonics have practically no influence on energy dispersion and phase bunching. (auth)

28669 TRANSVERSE MOTION OF ROTATIONALLY SYMMETRIC CHARGED PARTICLE BEAMS. Davies, A. J. (CERN, Geneva). Nucl. Instrum. Methods; 80: 45-54(1970).

A method is described for computing the transverse motion of rotationally symmetric, mono-energetic, charged particle beams allowing for the effects of space charge and particle overtaking. The method is extended to give a first approximation to the dynamics of a beam of finite emittance. A number of examples of the motion of a proton beam, of initially Gaussian density distribution radially, are given and the application to the pre-injector of the proton linear accelerator at CERN is briefly discussed. (auth)

28670 AUTOMATIC BEAM-EMITTANCE-MEASURING DEVICE FOR THE JUELICH ISOCHRONOUS CYCLOTRON (JULIC). Kuhlmann, W.; Bojowald, J.; Mayer-Boericke, C.; Reich, J.; Retz, A. (Kernforschungsanlage, Juelich, Ger.). Nucl. Instrum. Methods; 80: 89-94(1970).

An automatic beam emittance measuring device operating on the principle of the two slit method has been constructed and tested for the Juelich Isochronous Cyclotron. The device is described and typical results are presented. (auth)

28671 SYNCHROTRON INJECTOR AT THE HALF-WAY STAGE. Brianti, G.; Reich, K. H. CERN Cour.; 10: 71-7(Mar 1970).

A review of progress on the synchrotron injector for the CERN proton synchrotron is presented. The injector consists of four slow-cycling synchrotrons 50 m in diameter stacked vertically one on top of the other. The synchrotrons are filled in succession with the 50 MeV beam coming from the existing Linac. When the particles have been accelerated to 800 MeV the four circulating beams are extracted and recombined into a single beam for transfer into the PS. At this comparatively high energy, the space charge limit in the PS should be well beyond the intensity of 10^{13} protons per pulse which is aimed for. Injection, the main magnet system, rf accelerating system, vacuum system, beam transfer to the PS, beam observation and measurement, controls, buildings, and collaboration with industry are discussed. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 28646, 28732, and 28738.

28672 (AEEW-M-954) HEXCOH: A PROGRAMME FOR COMPUTING COHERENT ELASTIC SCATTER FROM HEXAGONAL POLYCRYSTALS. Butland, A. T. D. (Atomic Energy Establishment, Winfrith (England)). Nov 1969. 15p. Dep. CFSTI (U. S. Sales Only). UK 3s.

HEXCOH is a computer code written in FORTRAN II for the KDF9 computer to evaluate the isotropic and linearly anisotropic coherent elastic neutron cross sections in an isotropic polycrystalline solid with a close packed hexagonal lattice structure. The code can only be used at present for graphite, beryllium and beryllium oxide but may be easily extended to include other solids with hexagonal lattices. The cross sections can be computed as averaged values over a weighting spectrum and between energy boundaries specified in the input, or as point values. (UK)

28673 (ANL-Trans-806) NON-STATIONARY INTEGRO-DIFFERENTIAL TRANSPORT EQUATION. Morozov, S. F. Translated for Oak Ridge National Lab., Tenn., from Izv. Vyssh. Ucheb. Zaved., Mat.; No. 1, 26-31(1969). 11p. Dep. CFSTI.

The theorem of the existence of a solution for the integro-differential transport equation and the dependence of the differential properties of the solution on the initial conditions are established. The conditions are that the medium in which the reaction takes place is isotropic and homogeneous, that the particle velocities are identical, and that the scattering index can be a function of velocities and of the direction of the velocities and depends only on the cosine of the angle between them. (J.F.P.)

28674 (ORNL-TM-2879) THE ADJOINT BOLTZMANN EQUATION AND ITS SIMULATION BY MONTE CARLO. Irving, D. C. (Oak Ridge National Lab., Tenn.). 18 May 1970. Contract W-7405-eng-26. 36p. Dep. CFSTI.

The Boltzmann equation for neutron transport is discussed in both integro-differential and integral form. The "value" or "importance" equation is derived and shown to be equivalent, in the integral form, to the adjoint of the collision density. However, the value is also equivalent to the adjoint of the flux when the adjoint operation is carried out on the integro-differential equations. Possible ways of simulating both the forward and adjoint equations by Monte Carlo are discussed. Because the value equation is a "flux-like" equation, direct simulation of it proves to be unwieldy. Instead, a "collision density" for adjoint particles, equal to the value or adjoint flux times the total cross section, is introduced. The equation for this adjunction collision density may be simulated by the same routines as were used for the forward calculation and only the cross sections need to be changed. The extension of this to problems involving multiplying media is also included. (auth)

28675 (ORNL-TM-2942) DISPERSION RELATIONS SATISFIED BY THE NEUTRON WAVE FIELD. Moore, M. N.; Booth, R. S.; Perez, R. B. (Oak Ridge National Lab., Tenn.). 9 Apr 1970. Contract W-7405-eng-26. 31p. Dep. CFSTI.

It is shown that the inverse square magnitude of the propagation vector for neutron waves satisfies dispersion relations. Differentiation of these relations and evaluation of the resulting integrals at zero frequency lead to a set of equations for determining diffusion and thermalization parameters by performing integrals over experimental data. (auth)

28676 (ORNL-tr-2288) RESOLUTION OF THE TRANSPORT EQUATION BY THE METHOD OF INVARIANT IMBEDDING. Chapot, A. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Radioprotection; 3: 265-91(1968). 29p. Dep. CFSTI.

The method of invariant imbedding is presented by means of three examples. The first concerns an evaluation of the neutron dose in a simulation of the human body. The second studies the formation and the propagation of gamma rays coming from radiative capture of thermal neutrons in iron plates. At the beginning two auxiliary matrix algorithms are presented. (auth)

28677 (RPI-328-126) HOLPERT: A FORTRAN IV DIFFUSION THEORY PROGRAM FOR ESTIMATING THE EFFECT OF RE-ENTRANT HOLE IN ASYMPTOTIC-DECAY PULSED NEUTRON EXPERIMENTS. McGirt, F.; Becker, M. (Rensselaer Polytechnic Inst., Troy, N. Y. Div. of Nuclear Engineering and Science). Jun 1968. Contract AT(30-3)-328. 25p. Dep. CFSTI.

A FORTRAN IV program, HOLPERT, is described for determining the magnitude of the reentrant hole effect in asymptotic-decay pulsed neutron experiments using homogeneous slab geometry. The application of this program is limited to thermal problems with small spectrum distortions (the assumption of space–energy separability is valid). (J.F.P.)

28678 (TID-25165(Suppl.)) CINDA 69 SUPPLEMENT: AN INDEX TO THE LITERATURE ON MICROSCOPIC NEUTRON DATA. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn. Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut. ENEA Neutron Data Compilation Centre, Gif-sur-Yvette (France). International Atomic Energy Agency, Vienna (Austria). Nuclear Data Unit). 15 Jan 1970. 180p. DTIE Free.

New information added to the CINDA library since the publication of CINDA 69 is presented. (J.W.R.)

28679 MULLIKIN'S METHOD FOR SOLVING THE NEUTRON THERMALIZATION NONHOMOGENEOUS EQUATION. Caprini, L.; Corciovei, A.; Protopopescu, V. (Inst. for Atomic Physics, Bucharest). Nucl. Sci. Eng.; 39: 401-3(Mar 1970).

The solution to the nonhomogeneous Boltzmann equation in the diffusion approximation is obtained using the Mullikin method. Avoiding the question of the spectral properties of the integral operators, the method reduces the problem to a system of Cauchy singular integral equations whose exact solution displays an expected time-dependence. (J.W.R.)

28680 NEUTRON SOURCE REACTIONS AND $^{12}C(d,n_0)^{13}N$ DIFFERENTIAL YIELD CURVES BY A THICK-TARGET METHOD. Wylie, William Richard. Eugene, Oreg.; Univ. of Oregon (1969). 148p.

Thesis.

A think-target method for the purpose of establishing continuous calibration neutron sources and the study of neutron-producing charged-particle reactions was investigated. The pulsed-beam time-of-flight technique was used to measure continuous neutron spectra. It was shown that differential yield curves from charged-particle reactions can be obtained by transformation of thick-target neutron spectra. The energy resolution of the resulting yield curve is a function only of the neutron spectrometer. It was found that angular resolution degradation caused by small angle Coulomb scattering in the target could be made very small. The thick-target neutron spectrum of lithium + p was calculated from known thin-target cross sections and target stopping powers. The lithium spectrum was used to measure detector efficiencies for energies between .4 and 1.6 MeV. The $D(d,n)^3He$ reaction yield was measured for 6 neutron energies between 4.2 and 7 MeV using a gas target. These measurements were used to obtain the detector efficiencies at the higher energies. The $C^{NAT}(d,n)$ reaction was proposed as a neutron calibration source. The continuous neutron spectrum for neutron energies from 400 keV to 3.4 MeV was measured to an accuracy of ± 11% or less. The results are presented in the form of both absolute neutron-energy and time-of-flight spectra. The $^{12}C(d,n_0)^{13}N$ reaction yield curves for bombarding energies up to 3.8 MeV and laboratory angles to 160° in steps of 10° were obtained entirely by transformation of thick-target time-of-flight spectra. The energy resolution for most of the measurements is between 7 and 73 keV for neutron energies of .6 and 3 MeV respectively. A very weak resonance peak 20 keV wide was observed at the bombarding energy of 1.44 MeV. Strong interference between compound-nucleus resonances and between compound-nucleus and stripping amplitudes is evident at many energies. The total reaction cross sections obtained by integrating over the thick-target angular distributions and the Legendre polynomial expansion coefficients of the center-of-mass angular distributions show marked structure. The total thick-target yield was calculated by integrating the total cross sections over energy. (Diss. Abstr. Int., B.)

28681 EFFECTIVE ISOTROPIC SCATTERING KERNEL AND THE MULTIGROUP TRANSPORT EQUATION. Bergel'son, B. R.; Torlin, B. Z. At. Energ. (USSR); 27: 346-7(Oct 1969). (In Russian).

Neutron transport was previously studied by means of a multigroup equation system, using the transport approximation of the indicatrix of elastic scattering; however, the mean logarithmic energy loss used is not the true one and thus the statistical correlation between the scattering angle and the energy loss is disturbed. This was compensated for by introducing a new term into the expression. The representation used corresponds to a special form of the indicatrix encountered in the so-called synthetic

kernel method. The same expression may be obtained by a more formal derivation, analyzing the angular correlation of the indicatrix on the basis of the Legendre polynomial. The multigroup transport equation with an effective isotropic scattering indicatrix may be solved by means of the previously published computer program. (TTT)

28682 OUTER ITERATION SCALING IN NEUTRON TRANSPORT CODES. Clancy, B. E.; Donnelly, I. J. (Australian Atomic Energy Commission Research Establishment, Sutherland, New South Wales). Nucl. Sci. Eng.: 39: 398-400(Mar 1970).

A method of scaling each group flux after an outer iteration in order to ensure neutron balance is discussed. The method presented is an extension of DTF-IV, in which a single scaling factor is applied to all groups at the end of an outer iteration, but is not as general as the group and region-dependent scaling in GAMBLE-5. (L.W.A.)

28683 NEUTRON POLARIZATION STUDIES. Finlay, Roger W. (Ohio Univ., Athens). pp 311-36 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

Some of the problems encountered in neutron polarization measurements are discussed. The available data for the D(d, n)^{3}He source are compared. The techniques involving double scattering processes and associated particle time-of-flight are analyzed. (J.W.R.)

28684 CRYSTAL BINDING EFFECT OF UO_2 ON THE EFFECTIVE RESONANCE INTEGRAL. Kadotani, Hiroyuki (Tokyo Inst. of Tech.). J. Nucl. Sci. Technol. (Tokyo); 7: 115-25(Mar 1970).

The crystal binding effect on the effective resonance integral of UO_2 fuel was evaluated with a simplified phonon frequency distribution. A gaussian frequency distribution having one fitting parameter was adopted. With this distribution the line shape of the resonance cross section was expressed by a superposition of the ψ-functions, which lead to a rather simple calculation of the resonance integral. The calculated results on UO_2 crystals showed about 1% increase in the effective resonance integral at room temperature. Although this effect decreased at elevated temperatures, it conversely makes a 5 to 10% decrease in the Doppler coefficient compared with the free gas treatment. (auth)

28685 TWO-GROUP NEUTRON TRANSPORT THEORY IN SPHERICAL GEOMETRY. Schnatz, T. W.; Siewert, C. E. (North Carolina State Univ., Raleigh). J. Math. Phys. (N. Y.); 11: 766-71(Mar 1970).

A set of normal modes for the two-group steady-state neutron transport equation in spherical geometry is constructed. The singular eigenfunction-expansion technique is then used to develop a rigorous solution to the isotropically emitting spherical shell-source problem in an infinite medium. (auth)

28686 THEORY OF NEUTRON-WAVE PROPAGATION THROUGH AN INTERFACE. Baldonado, O. C.; Erdmann, R. C. (Univ. of California, Los Angeles). J. Math. Phys. (N. Y.); 11: 855-66(Mar 1970).

Neutron-wave propagation in a system consisting of two adjacent half-spaces having different properties is investigated using four models: (A) one-speed diffusion theory; (B) one-speed transport theory; (C) energy-dependent diffusion theory; (D) energy-dependent transport theory. An oscillating exponential source of neutrons is located in the left medium. Isotropic scattering is assumed for the transport models B and D, and a one-term degenerate kernel is used for the energy-dependent models C and D. Elementary solutions for each model are obtained and are used to construct the general solution. The resulting solutions are identified in terms of incident, reflected, and transmitted components of the wave. Both discrete and continuum solutions are seen to exist for models B, C, and D. The analyses given are exact except for model C, where the continuum solutions are neglected in the evaluation of the coefficients. The expansion coefficients in model B are evaluated by solving a Riemann–Hilbert problem with discontinuous coefficients. A similar, but generalized Riemann–Hilbert problem was solved to obtain the expansion coefficients in model D. (auth)

28687 ESTIMATION OF SELF-SHIELDING EFFECT FOR RADIOISOTOPES PRODUCTION. Nakamura, Haruto; Yamabayashi, Hisamichi (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 12: 2-6(Jan 1970). (In Japanese).

The thermal neutron flux distributions inside and outside cylindrical target materials of different sizes and different neutron absorption cross sections were determined to provide information necessary for deciding the shape and arrangement of target materials for radioisotope production. A geometrical function independent of the size and cross section of the target material is presented, which approximates the neutron flux distribution experimentally obtained. Calculations were made for hollow cylinders of infinitely thin wall and for thin disks. For such geometry the neutron flux decrease is proportional to the solid angle projected between source and target. The experimental values were found practically in agreement with the values calculated by the formulas. The self-shielding effect of most kinds of targets for radioisotope production can well be estimated approximately by using the formulas presented. (auth) (NSA of Japan)

28688 HALF-SPACE MULTIGROUP TRANSPORT THEORY. Pahor, S.; Shultis, J. K. (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.); 10: 2220-6(Dec 1970).

A method for solving various half-space multigroup transport problems for the case of a symmetric transfer matrix is explained. This method is based on the full-range completeness and orthogonality properties of the infinite-medium eigenfunctions. First, the albedo problem is considered. A system of Fredholm integral equations is derived for the emergent distribution of the albedo problem, and it is shown that this system has a unique solution. Then, by using the full-range eigenfunction completeness, the inside angular distribution is obtained from the emergent distribution. Finally, the Milne problem and the half-space Green's function problem are solved in terms of the emergent distribution of the albedo problem and the infinite-medium eigenfunctions. (auth)

28689 TRANSFER MATRIX SOLUTION OF SOME ONE- AND TWO-MEDIUM TRANSPORT PROBLEMS IN SLAB GEOMETRY. Aronson, Raphael (New York Univ., N. Y.). J. Math. Phys. (N. Y.); 11: 931-40(Mar 1970).

The transfer-matrix method is used to solve several one- and two-medium problems in plane geometry. The formal solutions are given in terms of operators which make no reference to the interactions or to the nature of the flux approximations. This formulation points up the structural similarities between solutions of various problems. (auth)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 27401 and 28680.

28690 (CEA-CONF-1485) n–n AND n–p INTERACTIONS FROM TWO COMPLETE EXPERIMENTS ON THE THREE-NUCLEON REACTION D(n,nnp) AT 14.5 MeV. Perrin, C.; Gondrand, J. C.; Durand, M.; Desreumaux, S.; Bouchez, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires. Grenoble Univ. (France). Institut des Sciences Nucleaires). Jul 1969. 24p. (CONF-690710-5). Dep. CFSTI (U. S. Sales Only).

From International Conference on the Three-Body Problem, Birmingham, England.

Two complete experiments on the reaction d(n,nnp) at 14.5 MeV have been performed with the same apparatus: a double time-of-flight spectrometer and a seven parameter analyser. The nn experiment, performed at (+30°, +30°) angles, near the nn pole, gave 4,400 events (≈22 mb/sr^2) in the peak. The np experiment at (+30°, −80°) angles, near the np pole, gave 2,800 events (≈4 mb/sr^2) in the peak. To analyse simultaneously both peaks, a simulation of both experiments by a Monte-Carlo method was carried out. Independently, a first iteration of the Faddeev equations with a separable potential was also done for the nn experiment. (auth)

28691 ANALYZER FOR THE POLARIZATION OF ^{3}He PARTICLES. McEver, W. S.; Clegg, T. B.; Joyce, J. M.; Ludwig, E. J. (Univ. of North Carolina, Chapel Hill. Triangle Universities Nuclear Lab., Chapel Hill, N. C.). Phys. Lett.; 31B: 560-2(27 Apr 1970).

Measurements have been made of the left-right asymmetry of polarized ^{3}He particles elastically scattered from ^{4}He. The results showed that the asymmetry in the scattering at $\theta_{LAB} = 26.0° \pm 2.5°$ was large (≈0.7) and constant over an energy range for the incident ^{3}He particles from 11.5 MeV to 13.0 MeV. These properties were useful in designing an analyzer which has enabled the first extensive ^{3}He polarization angular distributions to be obtained. (auth)

28692 D(d,p)T-REACTION WITH POLARIZED DEUTERONS BELOW 500 keV. Jeltsch, K.; Huber, P.; Janett, A.; Striebel, H. R. (Univ., Basel). Helv. Phys. Acta; 43: 279-95(15 May 1970). (In German).

The angular distributions of the D(d,p) T reaction at E_d = 150, 230, and 340 keV mean energy were measured with polarized incident deuterons. From these data the four independent components of the polarization efficiency D_1, D_{33}, $D_{11}-D_{22}$, and D_{13} are calculated and fitted as functions of the emission angle by the adequate associated Legendre functions. The energy dependence of the expansion coefficients is discussed, and it is shown that only below 300 keV the coefficients, except those due to quintet contributions, agree with theoretical predictions of Rook and Goldfarb. The ratio of vector- and tensor polarization in dependence of the probabilities of high-frequency transitions are investigated. (auth)

28693 REALISTIC NUCLEAR CHARGE-DENSITY OF THE GROUND STATE OF ^{4}He. Grypeos, M. E. (Univ. of Surrey, Guildford, Eng.). Lett. Nuovo Cim.; 3: 31-6(1 Jan 1970).

An attempt is made to obtain the nuclear charge density of ^{4}He through the use of the harmonic oscillator shell model and the Kallio-Kolltveit potential, a "realistic" nucleon-nucleon potential. The potential is used to calculate the charge-factor. (L.W.A.)

28694 A STUDY OF MEDIUM-ENERGY PROTON RADIATIVE CAPTURE BY DEUTERONS. Didelez, J. P.; Langevin-Joliot, H. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A143: 602-22(1970).

An experimental study of the D(p,γ)^{3}He reaction was carried out, from 17.5 to 150° (lab), with the 156-MeV Orsay synchrocyclotron proton beam. Results for the photon differential cross section are given and the experimental arrangement is described. The cross-section maximum occurs at 52° (c.m.), reaching a value of 0.21 μb/sr. A theoretical analysis is performed in the framework of the direct reaction mechanism, assuming the validity of the plane wave Born approximation. The deuteron S- and D-states and ^{3}He S, S' and three D-states are taken into account. It is found that distortion effects and reasonable admixture of S' and D-states cannot remediate to the observed discrepancy between experimental and theoretical results. Calculations made with five usual ^{3}He wave functions lead to the conclusion that direct reaction mechanism is not sufficient to explain the experimental angular distribution. (auth)

28695 NUCLEAR PHYSICS SYMPOSIUM, CALCUTTA, JULY 15-19, 1969. Baliga, B. B.; Nair, S. C. K. (eds.). Calcutta; Saha Institute of Nuclear Physics (1969). 74p. (CONF-690716).

Individual thoughts and opinions and research programs at Tata Institute of Fundamental Research, Saha Institute of Nuclear Physics, Physical Research Lab., Indian Statistical Institute, Aligarh Muslim University, Indian Institute of Technology, Banaras Hindu University are presented. The 14 talks are individually abstracted. (L.W.A.)

For abstracts of individual papers see: 28696-28700, 28802, and 28838-28845.

28696 ELECTROMAGNETIC MOMENTS OF EXCITED NUCLEAR STATES IN EVEN A NUCLEI. Bhattacherjee, S. K. (Tata Inst. of Fundamental Research, Bombay). pp 1-7 of Nuclear Physics Symposium, Calcutta, July 15-19, 1969. /Baliga, B. B. (ed.). Calcutta; Saha Institute of Nuclear Physics (1969).

See CONF-690716.

Anharmonic effects of vibration, revealed through the measurements of the quadrupole moments of excited 2^+ states and the measured magnetic moments of these states in near-spherical even A nuclei are discussed. Nonadiabatic effects of rotation, results of the isomer shifts in the 2^+ rotational states of some deformed nuclei, are also discussed. (L.W.A.)

28697 MODEL FOR Λ-HYPER NUCLEI. Ananthanarayanan, K. (MATSCIENCE, Madras). pp 12-19 of Nuclear Physics Symposium, Calcutta, July 15-19, 1969. Baliga, B. B. (ed.). Calcutta; Saha Inst. of Nuclear Physics (1969).

See CONF-690716.

The Brueckner-like attempt to compute the properties of hypernuclei from a model of the Λ-Λ interaction is discussed. The Λ-particle is assumed to move in an oscillator potential in the hypernucleus. The model calculation is performed with $^{\Lambda\Lambda}_{\Lambda\Lambda}$^{6}He and checked with ^{6}He. (L.W.A.)

28698 EXPERIMENTAL PROGRAMME OF THE MEMBERS OF THE NUCLEAR SPECTROSCOPY AND NUCLEAR REACTIONS GROUPS OF T.I.F.R. Bhattacharjee, S. K. (Tata Inst. of Fundamental Research, Bombay). pp 34-6 of Nuclear Physics Symposium, Calcutta, July 15-19, 1969. /Baliga, B. B. (ed.). Calcutta; Saha Inst. of Nuclear Physics (1969).

See CONF-690716.

A brief résumé of the experimental programs, which include work with the cascade generator, neutron capture gamma ray studies at CIRUS, work with the Van de Graaff at BARC, and various radioactivity experiments, is presented. (L.W.A.)

28699 ACTIVITIES OF THE NUCLEAR PHYSICS GROUP AT INDIAN INSTITUTE OF TECHNOLOGY, KANPUR. Mehta, G. K. (Indian Inst. of Tech., Kanpur, India). pp 37 of Nuclear Physics Symposium, Calcutta, July 15-19, 1969. /Baliga, B. B. (ed.). Calcutta; Saha Inst. of Nuclear Physics (1969).

See CONF-690716.

The experimental program which centers around a 2 MeV Van de Graaff machine and positron annihilation studies in organic media is outlined. (L.W.A.)

28700 CURRENT EXPERIMENTAL ACTIVITIES OF THE SAHA INSTITUTE OF NUCLEAR PHYSICS. Mukherjee, P. N. (Saha Inst. of Nuclear Physics, Calcutta). pp 38-9 of Nuclear Physics Symposium, Calcutta, July 15-19, 1969. /Baliga, B. B. (ed.). Calcutta; Saha Inst. of Nuclear Physics (1969).

See CONF-690716.

A brief summary is given of the high points of the experimental program, which centers around a cyclotron with a 3.8-MeV proton beam and a C-W generator which gives 14-MeV neutrons. (L.W.A.)

28701 EXPERIMENTAL STUDY OF THE VALIDITY OF THE GLAUBER THEORY FOR NUCLEAR PHYSICS. Friedes, J. L. (Brookhaven National Lab., Upton, N. Y.); Emerson, S. T.; Palevsky, H.; Simpson, W. D.; Sutter, R. J.; Stearns, R. L.; Von Witsch, W. Phys. Rev. Lett.; 24: 677-80(23 Mar 1970).

The elastic differential scattering cross section of protons on deuterons was measured for a series of incident proton momenta from 1.7 to 6.4 BeV/c. The observed scattering was compared with that predicted by the Glauber multiple-diffraction theory, out to momentum transfers of 1.0 BeV/c. Within experimental error (~10%), the experiments and theoretical predictions are in agreement. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 27382, 27401, 28467, 28561, 28680, 28695, 28696, 28698-28700, 28726, and 28854.

28702 (ANU-P-481) TENSOR POLARIZATION AND DIFFERENTIAL CROSS SECTION FOR THE ^{9}Be(d,d)^{9}Be ELASTIC SCATTERING AT LOW ENERGIES. Djaloeis, A.; Cords, H.; Nurzynski, J. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 20p. Dep. CFSTI (U. S. Sales Only).

Spin tensor moments $\langle T_{20}\rangle$, $\langle T_{21}\rangle$, $\langle T_{22}\rangle$ and the absolute differential cross sections for the ^{9}Be(d,d)^{9}Be elastic scattering measured at low deuteron energies are compared with the theoretical calculations based on the optical model containing spin-orbit and tensor T_R interactions. The Hauser-Feshbach statistical theory was used to account for the compound nucleus processes. (Australia)

28703 (ANU-P-482) DEUTERON-INDUCED REACTIONS IN ^{6}Li, ^{9}Be, AND ^{10}B AT BOMBARDING ENERGIES OF 4.5 TO 6.0 MeV. Powell, D. L.; Crawley, G. M.; Rao, B. V. N.; Robson, B. A. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 23p. Dep. CFSTI (U. S. Sales Only).

Angular distributions for the reactions ^{6}Li(d,p)^{7}Li (ground state and 0.48 MeV level), ^{9}Be(d,p)^{10}Be (ground state and 3.37 MeV level), ^{10}B(d,p)^{11}B (ground state, 2.12, 4.44 and 5.02 MeV levels) and the elastic scattering of deuterons on ^{6}Li and ^{9}Be have been measured for bombarding energies between 4.5 and 6.0 MeV. Absolute cross sections have been obtained for the ^{9}Be + d data. An analysis of the data has been made using the optical model and the distorted-wave and Hauser-Feshbach theories. (Australia)

28704 (TID-25379) STUDIES OF THE CROSS SECTIONS OF ^{3}H, ^{3}He, ^{4}He, AND ^{14}C IN THE BOMBARDMENT OF CARBON AND OXYGEN WITH HIGH-ENERGY PROTONS. Progress Report. Heymann, D.; Kruger, S. T. (Rice Univ., Houston, Tex.). 28 Feb 1970. Contract AT(40-1)-3815. 5p. Dep. CFSTI.

A brief review of the studies of the cross sections of ^{3}H, ^{3}He, ^{4}He, and ^{14}C in the bombardment of carbon and oxygen with high-energy protons at Rice University is presented. (L.W.A.)

28705 (UCLA-10-P-18-16) EXCITATION FUNCTIONS OF PROTON-INDUCED REACTIONS ON OXYGEN AT MEDIUM ENERGIES. Bunker, Stephen N. (California Univ., Los Angeles. Dept. of Physics). Dec 1969. Contract AT(11-1)-Gen-10. 145p. Dep. CFSTI.

The excitation functions of proton-induced reactions on oxygen between 20 and 40 MeV are discussed. Measurements for the excitation functions of inelastic scattering, (p,d), (p,t), and (p,α) reaction channels are presented. Results of the optical model, coupled-channels theory, and Ericson fluctuation analysis are compared to those of the doorway state theory, which provides a theoretical explanation of resonances at high excitation energies. Also presented are the parameters of resonances and the spin and parity results from the analyses. (L.W.A.)

28706 NUCLEAR PHOTON SCATTERING BETWEEN 10 AND 80 MeV. Ahrens, J.; Borchert, H.; Czock, K.-H.; Mehlig, D.; Ziegler, B. (Max-Planck-Inst. for Chemistry, Mainz). Phys. Lett.; 31B: 570-2(27 Apr 1970).

Dipole oscillator strengths for light elements were measured in a photon scattering experiment. The summed dipole strength up to 80 MeV photon energy was found to be 1.4 times the value given by the classical sum rules for all elements investigated. (auth)

28707 MEAN LIFETIME OF THE UNNATURAL PARITY STATES IN ^{16}O. Filosofo, I. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Nuovo Cim.; 66A: 449-74(21 Mar 1970).

The mean lifetimes of the 8.88(2^-)-, 10.94(0^-)-, and 11.08(3^+)-MeV states of ^{16}O were measured with the Doppler-shift attenuation method. A discussion about the experimental shift determination and its relation to the lifetime is reported. The experimental results for the lifetimes are discussed in connection with the description of the ^{16}O states in some nuclear models. (auth)

28708 QUADRUPOLE MOMENTS OF ^{10}B AND ^{11}B. Nesbet, R. K. (IBM Research Lab., San Jose, Calif.). Phys. Rev. Lett.; 24: 1155-7(25 May 1970).

A calculation of the electric field gradient in the ^{2}P ground state of atomic boron implies that the quadrupole moments of the stable boron isotopes, in barns, are $Q(^{10}B) = 0.084\ 72 \pm 0.000\ 56$, $Q(^{11}B) = 0.040\ 65 \pm 0.000\ 26$. (auth)

28709 SCATTERING OF 14.1 MeV NEUTRONS BY ^{10}B. Vaucher, B.; Alder, J. C.; Joseph, C. (Univ., Lausanne, Switzerland). Helv. Phys. Acta; 43: 237-53(15 May 1970).

The angular distributions of the differential cross sections for scattering of 14.1-MeV neutrons to the Q = 0, −1.74, −2.15, −3.58, −4.77, (5.11 + 5.16 + 5.18), − (5.92 + 6.04 + 6.13), −6.56, and − (6.88 + 7.0) MeV levels of ^{10}B were measured for $11° \leq \theta_{CM} \leq 164°$. They were deduced from the time-of-flight spectra of neutrons scattered by two targets of different ^{10}B and ^{11}B isotopic concentrations, with the help of a Monte Carlo program which reproduced the measured spectra. Owing to the small values of the measured cross sections, a precise determination of parasitic events was necessary. The elastic scattering was analyzed by the optical model. A coherent description of the inelastic scattering to the 2.15, 3.58, 5.16, and 6.56 MeV levels was achieved with the collective DWBA model. The not yet well-defined parity of the Q = −6.56 MeV level appears to be negative. (auth)

28710 POLARIZATION OF ^{3}He SCATTERED FROM ^{12}C. McEver, W. S. (Univ. of North Carolina, Chapel Hill. Triangle Universities Nuclear Lab., Durham, N. C.); Clegg, T. B.; Joyce, J. M.; Ludwig, E. J.; Walter, R. L. Phys. Rev. Lett.; 24: 1123-6(18 May 1970).

The polarization of ^{3}He particles elastically scattered from ^{12}C has been measured over an angular range $25° \leq \theta_{cm} \leq 74°$ at 18 MeV and $31° \leq \theta_{cm} \leq 61°$ at 20 MeV. Double-scattering techniques were used to determine the polarizations. A spin-orbit well depth of greater than 3 MeV is required in order to obtain reasonable agreement between optical-model predictions and the polarization data. (auth)

28711 NUCLEAR INTERACTION OF OXYGEN WITH OXYGEN. Maher, James Vincent Jr. New Haven; Yale Univ. (1969). 269p. Thesis.

The study of $^{16}O + ^{16}O$ elastic scattering in the energy range $10 \text{ MeV} \leq E_{CM} \leq 36 \text{ MeV}$ was undertaken both to search for narrow resonant structure analogous to that found in the $^{12}C + ^{12}C$ system and to look for potential scattering phenomena, relatively uncontaminated by compound nuclear effects. Excitation functions were measured throughout the above energy range, and three distinct widths of structure were found. First, potential scattering structure of ~2 MeV width and peak to valley ratio ~20/1 was observed, and a family of complex potentials were found to describe this structure. Theoretical studies by Brueckner, Greiner and others, inspired by the results of this work, have indicated that the $^{16}O + ^{16}O$ interaction potential depth should be shallow. This would restrict the above family of potentials to the few shallow alternatives. The second type of excitation function structure is very weak and narrow (width 75 keV). This is believed to arise from statistical fluctuations of the Ericson type. Analysis of this structure indicated that the $^{16}O + ^{16}O$ interaction is ≥ 94% direct. Finally excitation function structure was seen with a width ~150 keV and a strength much greater than that of the narrow fluctuations. Despite analysis of the phase shifts contributing to this structure and consideration of the statistical theory of the compound nucleus, the origin of this structure is unexplained. Several possible explanations are considered, including both various approaches to the statistical compound nucleus and several possible types of isolated resonant structure. Application of the Greiner theory to the present experimental data has permitted extraction, for the first time, of an empirical value for the compressibility of nuclear matter as represented by the ^{16}O nuclei; a value of 200 MeV is obtained. The Brueckner nuclear matter calculation, for finite system, results in an $^{16}O + ^{16}O$ interaction potential very similar to the shallowest empirically determined; more detailed comparison of theory and experiment in this nuclear system and in others now under study, shows promise of providing a unique probe for both the bulk and microscopic properties of nuclear matter. (Diss. Abstr. Int., B)

28712 PRECISION ELASTIC SCATTERING EXPERIMENTS. Armstrong, J. C. (Inst. for Defense Analyses, Arlington, Va.). pp 247-73 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

Some precision studies of proton elastic scattering on light nuclei below 3 MeV are briefly discussed. (J.W.R.)

28713 SURVEY OF (n,z) REACTIONS. Peck, R. A. Jr. (Brown Univ., Providence). pp 337-57 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

The current status of research on (n,z) reactions is surveyed. The theoretical picture of those processes and the nuclear information they have yielded so far are summarized. Some possibilities for the future are also discussed. (J.W.R.)

28714 PARTICLE-GAMMA ANGULAR CORRELATION EXPERIMENTS. Tilley, D. R. (North Carolina State Univ., Raleigh. Duke Univ., Durham, N. C.). pp 389-417 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

Some recent research on (d,pγ) and (^{3}He,$\alpha\gamma$) reactions is reviewed. The research includes both reaction mechanism studies and spectroscopic studies for determination of spins and multipole ratios. (J.W.R.)

28715 TRITON-INDUCED REACTIONS. Chase, L. F. Jr. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). pp 445-74 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

The problems involved in modifying a facility for low-energy triton acceleration, as well as the general nuclear instrumentation required to perform triton experiments, are described. Nuclear structure studies in triton reactions using both mechanism independent and mechanism dependent methods are discussed. Some suggestions for future research using triton beams are listed. (J.W.R.)

28716 LITHIUM-INDUCED REACTIONS. Carlson, R. R. (Univ. of Iowa, Iowa City). pp 475-96 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

The use of lithium ion beams in studies of nuclear structure and nuclear reaction mechanisms is described. Some experimental data on lithium-6 and -7 reactions with light nuclei are given as examples. (J.W.R.)

28717 RELATIVISTIC CORRECTIONS TO THE ft VALUES OF MIRROR NUCLEI AND OF ^{12}B AND ^{12}N. Strubbe, H. J.; Callebaut, D. K. (State Univ., Ghent). Nucl. Phys.; A143: 537-44(1970).

Considerable corrections to the ft values (2 to 9%) emerge when taking into account the small components of the nuclear wave functions in the calculations of the matrix elements ⟨1⟩ and ⟨σ⟩. The calculations are performed for several relativistic single-particle models; the resulting potential well parameters are in agreement with values which one currently obtains in non-relativistic calculations. The corrections turn out to be rather model independent. Coulomb distortion of the proton wave is included in the computation, but its effect is small. (auth)

28718 A MICROSCOPIC ANALYSIS OF THE (p,n) REACTION ON 1p-SHELL NUCLEI. Clough, A. S. (Queen Mary Coll., London); Batty, C. J.; Bonner, B. E.; Williams, L. E. Nucl. Phys.; A143: 385-403(1970).

The (p,n) reaction on ^{9}Be, ^{10}B, ^{11}B, ^{12}C, and ^{13}C was studied at incident proton energies of 30 and 50 MeV. Ground state and some excited state transitions were analyzed in terms of a microscopic reaction model. Evidence is presented for a strong energy dependence of the isospin-dependent "effective interaction" V_{01} and for a relatively weak energy variation of the spin-isospin term V_{11}. A comparison is also made between some (p,n) and (p,p′) reactions on ^{12}C populating analog final states. For the reaction ^{9}Be(p,n)^{9}B an attempt is made to extract spectroscopic information using the microscopic model. (auth)

28719 Be(t,t)^{9}Be AND ^{9}Be(t,α)^{8}Li REACTIONS AT 2.10 MeV. Cohen, Leslie; Herling, G. H. (Naval Research Lab., Washington, D. C.). Nucl. Phys.; A141: 595-601(1970).

Angular distributions and absolute cross sections are measured for elastic scattering and for the production of alpha particles corresponding to the ground state of ^{8}Li in the reactions ^{9}Be + t at 2.10 MeV. Optical-model description of the elastic scattering and DWBA description of the transfer reaction are discussed. A spectroscopic factor is extracted and compared to theoretical prediction. (auth)

28720 STUDIES OF (d,α) REACTION IN ^{19}F IN THE ENERGY RANGE FROM 1 TO 3.95 MeV. Zalyubovskii, I. I.; Lobkovskii, A. P.; Vysotskii, G. L. Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 2056-63(Dec 1969). (In Russian).

Excitation functions and angular distributions were measured for the ^{19}F(d,α) reaction at deuteron energies of 1 to 4 MeV, for the first four alpha groups. It was found that though the compound nucleus mechanism is prevalent, many experiments could be interpreted within the limits of variations of direct processes: two-particle capture, direct knock-on, and heavy stripping. The analysis of angular distributions in the region of the intense peaks in the excitation functions for the excitation energies of ^{21}Ne at 18.9, 19.4, and 19.9 MeV produced predominantly spins and parities of $5/2^{+}$. (R.V.J.)

28721 THE INFLUENCE OF SPIN-ORBITAL INTERACTIONS ON ELASTIC SCATTERING OF DEUTERONS BY LIGHT NUCLEI. Vereshchagin, A. N.; Simonov, I. N.; Terenetskii, K. O.; Tokarevskii, V. V.; Chernov, L. P. (Kiev State Univ. Tomsk Polytechnic Inst., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 2064-7(Dec 1969). (In Russian).

Optimum magnitudes for optical-model parameters were estimated for ^{9}Be, ^{11}B, ^{12}C, ^{24}Mg, ^{27}Al, ^{31}P, and ^{32}P, considering the spin-orbital interaction for ^{9}Be and ^{11}B. Additional studies were made with light nuclei using new experimental data on elastic scattering of 13.6-MeV deuterons by ^{16}O and ^{19}F and taking into account spin-orbit interactions in optical potentials for all investigated nuclei ^{9}Be, ^{11}B, ^{12}C, ^{16}O, ^{19}F, ^{24}Mg, ^{27}Al, ^{31}P, and ^{32}S. (R.V.J.)

28722 EMISSION OF CHARGED PARTICLES DURING μ-MESON CAPTURE BY ^{12}C NUCLEI. Vartanyan, V. A.; Zhusupov, M. A.; Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 2087-90 (Dec 1969). (In Russian).

The yield of charged particles was studied in relation to the general problem on the mechanism of μ-meson capture and nuclear structure. Studies on μ-capture by ^{12}C in a given channel carried out in a photoemulsion produced detailed information on the capture process in the case in which ^{8}Li is the final product. Decay and excitation schemes of the 1^{+} states of ^{12}B formed during permissible transitions in μ-meson capture in ^{12}C are analyzed. (R.V.J.)

28723 APPLICATION OF CLUSTER MODEL WAVE FUNCTIONS TO THE ^{12}C(d,p)^{13}C STRIPPING REACTION. El-Nadi, M.; Zohni, O. (Cairo Univ.). Nucl. Phys.; A142: 87-99(1970).

The α-cluster structure of ^{12}C was studied by the reaction ^{12}C(d,p)^{13}C (g.s.) at different incident deuteron energies in the range 2 to 28 MeV. Plane-wave calculations based on the cluster model description of the initial and final nuclei are compared with plane-wave calculations using the shell-model wave functions. The low-energy results show a marked preference for the shell-model description which agrees with the theoretical calculations using Faddeev's theory. An estimate of the rms radius of ^{12}C using the cluster assumption is also made. (auth)

28724 DOUBLE SPIN-ISOSPIN-FLIP REACTION. Nagatani, K. (Brookhaven National Lab., Upton, N. Y.); Boyd, D. P.; Donovan, P. F.; Beardsworth, E.; Assimakopoulos, P. A. Phys. Rev. Lett.; 24: 675-7(23 Mar 1970).

The reaction ^{6}Li(^{6}Li,^{6}Li*)^{6}Li*, where ^{6}Li* denotes the T = 1, $J^{\pi} = 0^{+}$ state at 3.56-MeV excitation, was experimentally studied. The angular distributions of this reaction and the elastic scattering were measured at 32.0-MeV bombarding energy. The differential cross section was measured at 90° in the center-of-mass system, for bombarding energies between 28.0 and 33.0 MeV. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 27101, 27382, 27393, 27394, 27477, 28467, 28482, 28695, 28696, 28698–28700, 28704, 28713–28715, 28720, 28721, 28767, 28769, and 28805.

28725 (AE–385) A NEUTRON ELASTIC SCATTERING STUDY OF CHROMIUM, IRON, AND NICKEL IN THE ENERGY REGION 1.77 TO 2.76 MeV. Holmqvist, B.; Johansson, S. G.; Lodin, G.; Salama, M.; Wiedling, T. (Aktiebolaget Atomenergi, Studsvik (Sweden)). 1970. 26p. Dep. CFSTI (U. S. Sales Only).

Elastic neutron scattering measurements were performed on the natural elements chromium, iron, and nickel. Angular distributions were recorded in the interval 20° to 160° at several energies in the region 1.77 to 2.76 MeV. The experimental data were analyzed in terms of the optical model, applying a spherical nuclear potential. (auth)

28726 (AECL–3512) PHYSICS DIVISION PROGRESS REPORT, JULY 1–SEPTEMBER 30, 1969. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). 77p. (PR-P-83). Dep. CFSTI (U. S. Sales Only). AECL $2.00.

BERYLLIUM-7 — electron-capture decay of, half-life for, (E)
CALCIUM-42 — energy levels from potassium-39 (α,p) reactions, lifetimes of, (E)
CHLORINE-37 — energy levels from proton inelastic scattering, (E)
CHROMIUM-51 — electron-capture decay of, half-life for, (E)
GERMANIUM-68 — energy levels from germanium-70 (p,t) reactions, spin-parity assignments for, (E)
GERMANIUM-69 — energy levels from germanium-70 (p,d) reactions, spin-parity assignments for, (E)
NEON-20 — energy levels from helium (O-16,γ) reactions, widths for, (E)
NIOBIUM-95 — beta decay of, half-life for, (E)
RHODIUM-103 — energy levels from chlorine-35 Coulomb excitation, spin-parity assignments for, (E)
SCANDIUM-42 — energy level at 611 keV from potassium-39 (α,n) reactions, lifetime of, (E)
TITANIUM-46 — energy levels from Coulomb excitation, quadrupole moments and transition probabilities for, (E)
TITANIUM-50 — energy levels from Coulomb excitation, quadrupole moments and transition probabilities for, (E)
(J.W.R.)

28727 (AEEW-M-887) A MEASUREMENT IN GLEEP OF THE THERMAL NEUTRON ABSORPTION CROSS SECTION OF A SAMPLE OF HIGHLY PURIFIED SILICON. Maddison, R. J.; Jones, P. M. V. (Atomic Energy Establishment, Winfrith (England)). Mar 1969. 5p. Dep. CFSTI (U. S. Sales Only). UK 1s. 6d.

A measurement was made in GLEEP of the thermal neutron absorption cross section of a highly purified sample of natural

silicon. This has given a value of 0.176 ± 0.005 barns compared with the previous value of 0.160 ± 0.020 barns. (auth)

28728 (ANU-P-479) ANGULAR CORRELATION STUDIES OF THE LOW-LYING LEVELS OF ^{57}Co. Coop, K. L.; Graham, I. G.; Titterton, E. W. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 36p. Dep. CFSTI (U. S. Sales Only).

Proton–gamma angular correlations and gamma-ray branching ratios were measured for the first nine excited states of ^{57}Co using the ^{54}Fe(α,pγ) reaction. In contradiction to earlier reports, the 1.754- and 2.127-MeV states were found to be single, well isolated states, and the 1.687-MeV state was observed to have a large gamma-ray branch (44%) to the ground state. From the data obtained here and in previous experiments, J^π values were deduced for the following levels whose energies are shown in MeV: 1.222, $\frac{3}{2}^-$ ($\frac{5}{2}^-$); 1.375, $\frac{3}{2}^-$; 1.502, $\frac{1}{2}^-$; 1.687, $1\frac{1}{2}^-$ ($\frac{3}{2}$, $\frac{5}{2}^-$); 1.754, $\frac{3}{2}^-$; 1.894, $\frac{1}{2}^-$; 1.917, $\frac{5}{2}^-$; 2.127, $\frac{1}{2}^-$ and 2.307, $\frac{1}{2}^-$ ($\frac{5}{2}^-$). Possible, but less probable, assignments have been enclosed in parentheses. (auth)

28729 (ANU-P-480) AN INVESTIGATION OF ^{59}Co AND ^{61}Co USING THE ^{56}Fe(α,pγ) AND ^{64}Ni(p,$\alpha\gamma$) REACTIONS. Coop, K. L.; Graham, I. G.; Titterton, E. W. (Australian National Univ., Canberra. Research School of Physical Sciences). [1969]. 32p. Dep. CFSTI (U. S. Sales Only).

The low-lying levels of ^{59}Co and ^{61}Co were investigated using particle-gamma coincidence techniques. Branching ratios were obtained for many states in ^{59}Co below 2.6 MeV excitation and angular correlations involving several states were measured using the ^{56}Fe(α,pγ) reaction. From the correlation data involving transitions from the 1.744-MeV state, assignments of $\frac{9}{2}^-$ ($\frac{5}{2}^-$), $\frac{5}{2}$ and $\frac{7}{2}^-$ were made for the 1.190-, 1.482- and 1.744-MeV states, respectively. The measured correlations involving the 1.100- and 1.291-MeV states were consistent with $\frac{9}{2}^-$ assignments for both. In ^{61}Co, the decay properties for many states below 2.3 MeV were determined. Probable spin assignments of $\frac{7}{2}$, $\frac{5}{2}$ or $\frac{3}{2}$ and $\frac{5}{2}$ or $\frac{3}{2}$ were deduced for the states at 1.623, 1.655 and 2.015, respectively. Systematics of the level structure of the odd-mass isotopes ^{57}Co, and ^{59}Co and ^{61}Co were examined and many similarities noted. (Australia)

28730 (ANU-P-485) EXPERIMENTAL STUDY OF LOW-LYING LEVELS AND DECAY STRUCTURE IN THE NUCLEUS ^{62}Cu. Davidson, W. F.; Najam, M. R.; Dallimore, P. J.; Hellstroem, J.; Powell, D. L. (Australian National Univ., Canberra. Research School of Physical Sciences). [1970]. 16p. Dep. CFSTI (U. S. Sales Only).

The reaction ^{62}Ni(p,nγ)^{62}Cu was used to investigate the low-lying levels of ^{62}Cu and their γ-decay. Gamma-ray angular distributions were carried out using incident proton energies close to threshold for the states under investigation and comparison of these results were made with the predictions of the compound nucleus statistical model. In addition to levels seen in the β^+/EC decay of ^{62}Zn, namely the ground state (1^+), 40.84 keV (2^+), 243.43 keV (2^+), 287.86 keV (2^+), 548.25 keV (1^+) and 637.20 (1^+), other levels were found at 389.9 keV, 426.1 keV, 644.9 keV, 675.1 keV, 698.3 keV, 727.5 keV, 756.3 keV and 915.5 keV. The 426.1 keV, 675.1 keV and 727.5 keV states are assigned to be 3^+, 3^+ and $2^{(+)}$, respectively, and possible spin values for the remaining levels are advanced. Gamma ray branching ratios were obtained, and a decay scheme for ^{62}Cu comprising 30 transitions is presented. (auth) (Australia)

28731 (COO-1167-8) THE PRODUCTION OF ^{54}Mn AND ^{65}Zn FROM COPPER IN THICK TARGETS BY 0.45 GeV, 1.0 GeV, AND 3.0 GeV PROTONS. Van Ginneken, A.; Turkevich, Anthony (Chicago Univ., Ill. Enrico Fermi Inst. Chicago Univ., Ill. Dept. of Physics). [1969]. Contract AT(11-1)-1167. 55p. Dep. CFSTI.

The production of ^{54}Mn and ^{65}Zn from copper was measured radiochemically at various depths and radial distances inside thick targets (up to 1m in size) which were irradiated with 0.45-, 1.0- and 3.0-GeV protons. The targets consisted mainly either of copper or iron. Based on the yields in these targets, the total number of ^{54}Mn atoms produced per incident proton in a semi-infinite body of copper is 2.9×10^{-2} at 0.45 GeV, 7.5×10^{-2} at 1.0 GeV and 2.0×10^{-1} at 3.0 GeV; the corresponding values for ^{65}Zn are 3.7×10^{-3}, 7.0×10^{-3} and 1.9×10^{-2}. The experimental results were compared with those of a Monte Carlo calculation which simulates the propagation of internuclear cascades in dense materials. The yields of ^{54}Mn and ^{65}Zn were computed as a function of location in the target from the particle fluxes given by the Monte Carlo calculation and from experimental excitation functions. The agreement is excellent for the production rates integrated over the target. It is generally good for the radially integrated dependence on depth but less satisfactory for detailed fits of the spatial distributions. Effects of finite beam size vis-a-vis the pencil beam of the calculation are discussed and their inclusion is shown to improve the detailed comparisons. The Monte Carlo calculation has demonstrated the importance of internuclear cascade effects in thick targets: e.g., at 3.0 GeV about 90% of the ^{54}Mn and virtually all of the ^{65}Zn is made by other particles than the primary ones. An analysis is presented of the different mechanisms by which a specific product can be made when high energy particles enter large bodies, and the relative contribution of each of these mechanisms to the production of ^{65}Zn and ^{54}Mn in copper is evaluated. (auth)

28732 (IEA-152) WORKS PRESENTED TO THE DIVISION OF NUCLEAR PHYSICS IN THE ANNUAL MEETING OF THE BRAZILIAN PHYSICAL SOCIETY. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Oct 1967. 148p. (In Portuguese). Dep. CFSTI (U. S. Sales Only).

The 25 papers presented at the annual meeting of the Brazilian Physical Society are compiled. The topics discussed are the resolution of the crystal spectrometer of the IEA and measurement of the iridium resonances, experimental determination of the characteristics of neutron monochromatic crystals, paramagnetic scattering of neutrons by rare earth ions, characteristics of the 4π-type pill box counter, counting system for 4π α–β coincidences, absolute measurement of the specific activity of radioactive solutions: determination of mass and factor of dilution; international comparison of absolute measurement of specific activity of two solutions of ^{60}Co, absolute measurements of activities of 4π β–γ coincidences with the results of international comparison of the measurement of ^{60}Co solutions, resolution and calibration of a time-of-flight spectrometer which uses a shutter for slow neutrons, experimental arrangement for the study of solids and liquids attacked by the inelastic scattering of slow neutrons, measurement of the total collision cross section of ferro polycrystals for slow neutrons, total collision cross section of UO_2 for slow neutrons, study of rotation of CH_3 groups in molecules by measurement of the total collision cross section for slow neutrons, scattering of slow neutrons in lead, adjustment of the monochromator crystal of the neutron diffractometer of the IEA, determination of the wave length of a monochromatic bundle and correction of scattering angle from the sample in the neutron diffractometer, study of the resolution and intensitity of a neutron diffractometer, fission chamber with multiple parallel plates, the form of the internal conversion lines observed in the β spectrometer, study of the internal conversion electrons of ^{162}Dy obtained by (n,e$^-$) reactions, conversion electrons of ^{188}Re after radioactive capture of neutrons, matrix representation for the calculation of second order aberrations in particle optics for homogeneous and inhomogeneous fields (n = 1), decay of ^{62}Zn, study of γ radiation from neutron capture, and use of solid state detectors in the quantitative determination of radionuclide mixtures in biological materials. (J.S.R.)

28733 (KFK-1083) PRODUCTION OF ^{7}Be, ^{22}Na, ^{24}Na, AND ^{28}Mg BY IRRADIATION OF ^{27}Al WITH 52 MeV DEUTERONS AND 104 MeV ALPHA PARTICLES. Martens, U.; Schweimer, G. W. (Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron-Laboratorium). Nov 1969. 18p. Dep. CFSTI (U. S. Sales Only).

Excitation functions for the production of ^{7}Be, ^{22}Na, ^{24}Na and ^{28}Mg by irradiation of ^{27}Al with deuterons and alpha particles were measured for the energy range available with the Karlsruhe Isochronous Cyclotron. The error in the absolute cross section scale is estimated to be 2.5%. The error in the energy scale is about 1 MeV in the threshold region and 0.5 MeV at the maximum energy. (auth)

28734 (ORNL-4519) CALCIUM NEUTRON ELASTIC- AND INELASTIC-SCATTERING CROSS SECTIONS FROM 4.0 TO 8.5 MeV. Perey, F. G.; Kinney, W. E. (Oak Ridge National Lab., Tenn.). Apr 1970. Contract W-7405-eng-26. 51p. Dep. CFSTI.

Numerical values are given for neutron elastic- and inelastic-scattering cross sections from Ca in the range of 4.0 to 8.5 MeV. A brief description of the experimental and data-reducing techniques is presented to assist in the evaluation of the data. Elastic angular distributions at two energies are in very good agreement with previous data. There does not exist any previous measurement of inelastic scattering with which to compare the data. The data are compared with the present ENDF/B evaluation. Very good agreement is found for elastic scattering. For inelastic scattering the shapes of the angular distributions are in fair agreement, but there are some serious discrepancies in the magnitudes of the cross sections. (auth)

28735 (ORNL-4523) ^{60}Ni NEUTRON ELASTIC- AND INELASTIC-SCATTERING CROSS SECTIONS FROM 6.5 TO 8.5 MeV.

Perey, F. G.; Le Rigoleur, C. O.; Kinney, W. E. (Oak Ridge National Lab., Tenn.). Apr 1970. Contract W-7405-eng-26. 81p. Dep. CFSTI.

Numerical values are given for neutron elastic- and inelastic-scattering cross sections from nickel-60 at five energies from 6.5 to 8.5 MeV. A brief description of the experimental and data-reducing techniques is presented to assist in the evaluation of the data. Angular distributions are given for elastic scattering and inelastic scattering to the low-lying excited states. Above 3 MeV of excitation in the residual nucleus, the experimental energy resolution is inadequate to resolve the inelastic scattering to individual levels. This continuum portion of the inelastic spectrum presents much structure which is very similar at all the energies. Angular distributions were extracted for the five lowest peaks in this continuum which are at about 3.2, 3.7, 4.1, 4.4, and 4.6 MeV of excitation. (auth)

28736 (ORNL-TM-2861) 11-MeV PROTON INELASTIC SCATTERING FROM EVEN-EVEN MEDIUM WEIGHT NUCLEI. Perey, C. M.; Silva, R. J.; Dickens, J. K.; Perey, F. G. (Oak Ridge National Lab., Tenn.). 29 Jan 1970. 31p. Dep. CFSTI.

The analysis of inelastic scattering of 11 MeV protons from quadrupole and octupole collective levels of 14 even-even nuclei between ^{46}Ti and ^{76}Ge is reported. The distorted wave Born approximation is used to calculate the cross sections using the collective model generalization of the optical model for inelastic scattering. The analysis is performed using both real and complex form factors for the model. A satisfactory description of all of the data is obtained when a contribution due to compound nucleus decay for most of the octupole levels and a few of the quadrupole levels is included. (auth)

28737 (ORNL-TM-2883) $^{28-30}$Si(n,xγ) REACTION FOR 5.3 ≤ E_n ≤ 9.0 MeV. Dickens, J. K. (Oak Ridge National Lab., Tenn.). 13 Feb 1970. 43p. Dep. CFSTI.

Interactions of neutrons with silicon were studied by measuring gamma-ray-production cross sections. For incident mean neutron energies E_n = 5.35, 5.85, 6.4, 6.9, 7.45, 7.95, 8.5, and 9.0 MeV spectra were obtained for a natural silicon sample. The gamma rays were detected using a coaxial Ge(Li) detector of 30 cm^3 active volume. Data were obtained for gamma-ray scattering angles of 55 and 90° for all E_n, of 35° for E_n = 7.45 and 8.5 MeV, and 75° for E_n = 6.4 and 7.45 MeV. Time-of-flight was used with the detector to discriminate against pulses due to neutrons and background radiation. Data were also obtained at E_n = 5.9 MeV, θ_γ = 55° for a sample of $^{29}SiO_2$ enriched to 95% in ^{29}Si, and for a similarly enriched sample of $^{30}SiO_2$. These data were studied to obtain absolute cross sections for production of gamma rays for the incident neutron energies quoted above. The cross sections were compared, where possible, with previously measured values with fair agreement. The spectra were studied for gamma rays which could be associated with deexcitation of nuclear levels having unknown decay modes. For ^{29}Si gamma rays were found having energies appropriate for decay of levels at excitation energies E_x = 4.736, 4.836, 4.893, and 5.249 MeV. For ^{30}Si gamma rays were found for decay of levels at excitation energies $E_x \geq$ 4.826 MeV. The spin of the 4.826-MeV state in ^{30}Si is reasonably limited to 2, 3, or 4. No previously unknown transitions were found for ^{28}Si or ^{25}Mg; for ^{27}Al the evidence suggests that the 1.624-MeV level is a doublet of 3 keV separation. (auth)

28738 (RPI-328-171) LINEAR ACCELERATOR PROJECT. Annual Technical Report, October 1, 1968-September 30, 1969. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-1)-328. 177p. Dep. CFSTI.

COPPER-65—neutron capture of 229 eV, transmission measurement of, (E)
EXPONENTIAL PILES—neutron spectra in aluminum, re-entrant hole perturbation effects on fast, (E)
—neutron spectra in aluminum, time-dependent fast, (E)
IRON—neutron elastic scattering at 1 to 500 keV, neutron spectra from, (E)
NEUTRONS, FAST—spectra in aluminum assembly, re-entrant hole perturbation effects on, (E)
—spectra in aluminum assembly, time-dependent, (E)
PROMETHIUM-147—neutron capture at 5 to 316 eV, resonance parameters for, (E)
SCANDIUM-45—photon reactions (γ,n), (γ,2n), and (γ,p) at 25 to 76 MeV, analysis using various level density parameters, (E/T)
TANTALUM-182—energy levels from tantalum-181 neutron capture, occupation ratios for, (E) (J.W.R.)

28739 (RPI-328-185) A MEASUREMENT OF THE RADIATION WIDTH OF THE 2.85-keV RESONANCE AND OF THE THERMAL CAPTURE CROSS SECTION IN SODIUM. Yamamuro, N.; Hockenbury, R. W.; Block, R. C.; Wolfe, R. H. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Science). [1970]. Contract AT(30-1)-328. 23p. Dep. CFSTI.

Neutron radiative capture measurements upon samples of sodium were carried out using a 100-MeV electron linear accelerator. The radiation width of the 2.85-keV resonance was determined to be (0.47 ± 0.045) eV. The capture cross section in the 0.025 to 0.200 eV energy range had a $1/v$ energy dependence (to an accuracy of ±2%), and a capture cross section of (0.50 ± 0.03) barn was obtained at 0.0253 eV. The measured radiation width of the 2.85-keV resonance is approximately 50% greater than the radiation width that is inferred from the thermal capture cross section. (auth)

28740 β-γ CIRCULAR POLARIZATION CORRELATION NUCLEAR MATRIX ELEMENTS OF β TRANSITIONS. CASE OF ^{86}Rb. Viano, J. B.; Renard, J. C.; Menet, J.; de Saintignon, P.; Laverne, A.; Depommier, P. (Univ., Grenoble, France). J. Phys. (Paris); 30: 763-72(Oct 1969). (In French).

In order to determine the nuclear matrix elements (N.M.E.) for the β transition ^{86}Rb (2$^-$; g.s.) → ^{86}Sr (2$^+$; 1.08 MeV), the circular polarization of the 1.08-MeV γ in coincidence with the β spectrum was measured for a few values of the angle $\theta_{\beta\gamma}$. The results are not in agreement with previous experiments. The data and those from β-γ directional correlation and β spectrum shape factor measurements were used to derive the six N.M.E. by fitting the experimental data with Morita and Morita's theoretical expressions. The N.M.E. obtained are compared with Walhborn's theoretical predictions. Some of his conclusions may have to be modified. (auth)

28741 SPIN OF THE 426 keV LEVEL IN ^{62}Cu. Davidson, W. F.; Dallimore, P. J.; Hellstrom, J. (Australian National Univ., Canberra). Aust. J. Phys.; 23: 11-15(Feb 1970).

The spin and parity of the 426-keV level in ^{62}Cu excited through the ^{62}Ni(p,nγ)^{62}Cu reaction were measured to be 3$^+$. (Australia)

28742 CALCULATION OF GAMMA-RAY TRANSITION PROBABILITIES IN ODD-A NUCLEI. Yost, K. J.; Pitkanen, P. H.; Fu, C. Y. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng.; 39: 379-86(Mar 1970).

Gamma-ray transition probabilities intended for use in the preparation of gamma-ray production cross sections have been calculated for ^{23}Na, ^{57}Fe, ^{183}W, and ^{239}Pu and compared with experiment. Wave functions used in the calculation of M1 and E2 transition matrix elements were generated with a deformed shell (Nilsson) model code which allows for asymmetric quadrupole deformations. Inverse moments of inertia and deformations were treated as adjustable parameters. The collective gyromagnetic ratio was assumed to be a constant for all levels. The results suggest in the context of the simplified model an angular momentum dependence of the nuclear deformation. (auth)

28743 A STUDY OF TRITON INDUCED REACTIONS IN ^{37}Cl AND ^{44}Ca. Ajzenberg-Selove, F. (Haverford Coll., Pa.); Igo, G. Nucl. Phys., A142: 641-8(1970).

The ^{44}Ca(t,α)^{43}K, ^{44}Ca(t, ^{3}He)^{44}K, and ^{37}Cl(t, ^{3}He)^{37}S reactions were studied with a beam of 20-MeV tritons and an Elbek-type spectrograph. Forty excited states of ^{43}K are reported in the range 0 < E_x < 5.4 MeV. The atomic mass excesses of ^{44}K and ^{37}S were determined to be −35.78 ± 0.04 and −26.89 ± 0.03 MeV, respectively. Six excited states of ^{44}K were observed below E_x = 1.6 MeV, and eight excited states of ^{37}S were located below E_x = 3.4 MeV. (auth)

28744 ^{49}Fe: A NEW T_z = −3/2 DELAYED-PROTON EMITTER. Cerny, Joseph; Cardinal, C. U.; Evans, H. C.; Jackson, K. P.; Jelley, N. A. (Oxford Univ.). Phys. Rev. Lett.; 24: 1128-30 (18 May 1970).

Iron-49 with a half life of 75 ± 10 msec was produced by the reaction ^{40}Ca(^{12}C, 3n)^{49}Fe using 65-MeV carbon ions; beta-delayed protons with an energy of 1.96 ± 0.05 MeV probably originating from the lowest T = 3/2 state in ^{49}Mn were observed. (auth)

28745 SPLITTING OF THE GIANT RESONANCE IN ^{26}Mg. Titze, O.; Goldmann, A.; Spamer, E. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett.; 31B: 565-6(27 Apr 1970).

Inelastic electron scattering experiments show a splitting of the E1 giant resonance in ^{26}Mg which is discussed in terms of isospin splitting. (auth)

28746 NUCLEAR RESEARCH WITH LOW ENERGY ACCELERATORS. Proceedings of the Symposium Held at College Park, Maryland, June 19-24, 1967. Marion, Jerry B.; Van Patter, Douglas M. (eds.). New York; Academic Press Inc. (1967). 524p. $13.00. (CONF-670615).

Separate abstracts were prepared for the 22 papers included. (J.W.R.)

For abstracts of individual papers see: 27370, 27391–27394, 27957, 28683, 28712–28716, 28747–28750, 28793, 28794, and 28828–28831.

28747 GAMMA-RAY ANGULAR CORRELATION STUDIES AND ISOBARIC ANALOG STATES IN 2s–1d SHELL NUCLEI. Harris, Gale I. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). pp 17–41 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

A brief review of the formalism and techniques of angular correlation measurements as applied to proton capture is given. Some recent data on $1f_{\frac{7}{2}}$ and $2p_{\frac{3}{2}}$ analog states in 2s–1d shell nuclei are summarized. (J.W.R.)

28748 LIFETIME MEASUREMENTS WITH BREMSTRAHLUNG. Booth, Edward C. (Boston Univ.). pp 75–97 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

Nuclear electromagnetic transition probabilities can be measured by various methods including electron scattering, Coulomb excitation, and nuclear resonance fluorescence. Some studies conducted using 3-MeV electron accelerators are discussed with special emphasis on the last method. (J.W.R.)

28749 ANALOG-STATE EXPERIMENTS. Morrison, George C. (Argonne National Lab., Ill.). pp 275–309 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

The general features of isobaric analog resonances are described and some examples from low-energy reactions are presented. The possibilities for analog-state experiments with low-energy accelerators are discussed. Some experiments pertinent to the theoretical understanding of analog states are analyzed in detail. (J.W.R.)

28750 NEUTRON INELASTIC SCATTERING BY TIME-OF-FLIGHT. Smith, A. B. (Argonne National Lab., Ill.). pp 359–87 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

The status of inelastic neutron scattering studies using fast time-of-flight techniques is reviewed in the context of nuclear models and structure. (auth)

28751 MEASUREMENT OF RESONANCE ACTIVATION INTEGRAL OF ^{55}Mn. Nanjyo, Tsutomu (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 126–9(Mar 1970).

The resonance activation integral of ^{55}Mn was measured relative to that of ^{197}Au by absolute counting of ^{56}Mn and ^{198}Au: ^{56}Mn was measured with a Ge(Li) counter whose detecting efficiency for γ rays had been previously determined by a set of IAEA calibrated γ sources, while ^{198}Au was measured with a $4\pi\beta$-γ coincidence counter. The neutron spectrum was determined by P_1 calculation and was verified by a time-of-flight method. The ratio $I_{1/v}/I_{res}$ was obtained experimentally making use of boron filters of three different thicknesses. The results were $I_{total} = 14.1 \pm 0.6$ barn and $I_{1/v}/I_{res} = 0.57 \pm 0.06$, for a cutoff energy of 0.63 eV. (auth)

28752 NUCLEAR STRUCTURE STUDIES BY THE $^{62\text{-}64}$Ni (d,p) REACTION. Turkiewicz, I. M.; Beuzit, P.; Delaunay, J.; Fouan, J. P. (CEN, Saclay, France). Nucl. Phys.; A143: 641-51(1970).

Levels of ^{63}Ni and ^{65}Ni below 5 MeV were studied by observation of the energy and angular distribution of protons emitted in the $^{62\text{-}64}$Ni(d,p) reactions. For many levels, l-values of the captured neutrons were assigned by comparison of the angular distribution with calculations based on the DWBA. These comparisons yield the spectroscopic factors. A sum rule analysis is made and the results are compared with the predictions of the strong-pairing and shell models. The positions of the single quasiparticle states determined were used as input for an IGE calculation to obtain the force parameters. (auth)

28753 POLARIZATION AND ANGULAR CORRELATION MEASUREMENTS FOLLOWING THE ^{40}Ar(p,nγ)^{40}K REACTION. Twin, P. J.; Olsen, W. C.; Sheppard, D. M. (Univ. of Alberta, Edmonton). Nucl. Phys.; A143: 481-96(1970).

Gamma-ray angular distributions and polarization correlations were measured using the reaction ^{40}Ar(p,nγ)^{40}K. All the experiments were carried out with bombarding energies close to threshold for the states under investigation. Comparison with compound nuclear predictions yielded the following spin assignments to states in ^{40}K; 1.959(2^+), 2.047(2^-), 2.070(3^-), 2.103(1^-), 2.261(3^+), 2.290(1^+), 2.291(4,(3)), 2.419(2,3), 2.575(2,4) and 2.625(0^-). Multiple mixing ratios together with the gamma-ray branching ratios were determined for all these levels. A short theoretical treatment of the polarization of gamma rays from aligned nuclei using the phase-consistent formalism of Brink and Rose is included. (auth)

28754 Γ DECAY FROM THE ANALOGUE STATE OF ^{51}Ti g.s. Gaarde, C.; Kemp, K.; Naumov, Yu. V.; Amundsen, P. R. (Univ. of Copenhagen). Nucl. Phys.; A143: 497-511(1970).

The γ-decay from the analog state of the ^{51}Ti g.s. is studied. It is shown that most of the T> strength is concentrated in a single state. Absolute widths for the transitions from the analog state to 17 lower-lying states in ^{51}V are given. Strong dipole transitions are observed to a group of states around 5 MeV below the analog state. It is believed that the transitions are M1 transitions and that the states carry a significant part of the Gamow–Teller strength. The absolute widths for the transitions to the first and second excited states are compared with the ft values for the corresponding β-decay of ^{51}Ti. (auth)

28755 (α,^{3}He) AND (α,t) REACTIONS ON ^{40}Ca. Youngblood, D. H.; Kozub, R. L.; Hiebert, J. C.; Kenefick, R. A. (Texas A and M Univ., College Station). Nucl. Phys.; A143: 512-28(1970).

Angular distributions were measured for several levels excited in the ^{40}Ca(α,^{3}He) ^{41}Ca and ^{40}Ca(α,t)^{41}Sc reactions at 40 MeV bombarding energy. ^{3}He and triton groups corresponding to several known levels in ^{41}Ca and ^{41}Sc were observed, in addition to ^{41}Sc levels at 3.356 ± 0.020 and 3.905 ± 0.020 MeV excitation energy which were not reported previously. DWBA calculations were performed in both the zero- and finite-range approximations, and spectroscopic factors are compared with the results of other reactions. The (α,^{3}He) and (α,t) reactions appear to selectively excite analog states in the ^{41}Ca–^{41}Sc mirror nuclei, most of which correspond to an l = 3 or l = 4 angular momentum transfer. (auth)

28756 GAMMA-RAY STUDY OF LOW-LYING STATES OF ^{41}Ca. Johnson, G.; Blake, R. S.; Laurent, H.; Picard, F.; Schapira, J. P. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A143: 562-76(1970).

Angular correlations were performed to determine the spin and parity of some bound states of ^{41}Ca. The decay scheme of 11 levels was established. An 80% transition between the 3378- and 3209-keV levels was confirmed in p-γ coincidence measurements. The spin of the 3614-keV level is shown to be $\frac{5}{2}^-$, and quantitative arguments are given to identify that state with the one predicted by Gerace and Green, to be mainly of 3p–2h character. (auth)

28757 ANALYSIS OF THE PROPERTIES OF THE ODD-MASS SINGLE CLOSED SHELL NUCLEI WITH A SURFACE DELTA INTERACTION. Arvieu, R.; Bohigas, O. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A143: 577-601(1970).

The surface delta interaction was applied in a calculation of the odd-mass isotopes of Ni and Pb and of the nucleus ^{211}At. Exact shell-model calculations were performed in all cases except for lead isotopes containing more than three holes (^{203}Pb–^{197}Pb). The Bogolyubov–Valatin method combined with the Tamm–Dancoff approximation in the subset of one- and three-quasiparticle configurations was also used. The comparison between the results obtained in those two ways shows that the quasiparticle method works rather well. The agreement with experiment is quite good in general and is comparable with that achieved with more complicated interactions. The exact wave functions were analyzed in terms of the coupling of a particle or a hole to the ground state of the neighboring nuclei with only two particles or holes outside closed shells. Finally the theoretical spectroscopic factors of the reactions ^{58}Ni(d,p)^{59}Ni, ^{206}Pb(d,t)^{205}Pb and ^{206}Pb(p,d)^{205}Pb were studied in connection with this analysis and compared with the experimental results and calculations by other authors. (auth)

28758 IDENTIFICATION OF ^{86}Se AND SEARCH FOR DELAYED NEUTRON EMISSION FROM ^{87}Se AND ^{88}Se. del Marmol, P.; Perricos, D. C. (CEN-SCK, Mol, Belgium). J. Inorg. Nucl. Chem.; 32: 705-12(Mar 1970).

^{87}Se and ^{88}Se are separated by short time intervals from ^{235}U irradiated with thermal neutrons. Their half-lives were measured through the neutron activities of their bromine daughters as 5.9 ± 0.2 sec for ^{87}Se and 1.3 ± 0.3 sec for ^{88}Se, and the ^{87}Se fission yield was 0.65 ± 0.13 per cent. From a delayed neutron activity consistent with the ^{87}Se half-life and in constant ratio with the

^{81}Br activity, a neutron emission probability (P_n) value of 0.23 ± 0.07 per cent was evaluated for ^{87}Se. Evidence was not conclusive as regards delayed neutron emission from ^{88}Se, for which an upper limit of $P_n \leq 1$ per cent was estimated. (auth) (UK)

28759 ACTIVATION MEASUREMENTS OF THERMAL NEUTRON CAPTURE CROSS-SECTIONS AND RESONANCE INTEGRALS. Ryves, T. B. (National Physical Lab., Teddington, Eng.). J. Nucl. Energy; 24: 35-42(Feb 1970).

The standard thermal neutron flux at the NPL was used to measure a number of 2200 m/s activation cross sections and resonance integrals relative to those of Au. The calculated accuracy of the cross sections in most cases was at least 2%, the main uncertainty being due to the determination of the β-counting efficiency of the activated samples. (auth) (UK)

28760 ABSOLUTE CROSS SECTION MEASUREMENT OF THE ELEMENTARY PROCESS OF BREMSSTRAHLUNG PRODUCTION. Nakel, W.; Sailer, U. (Univ., Tuebingen, Ger.). Phys. Lett.; 31A: 181-2(23 Feb 1970).

The absolute cross section of electron bremsstrahlung that is differential with respect to the photon energy and to the photon and electron emission angles was measured by using a coincidence technique. The incident electron energy was 300 keV. (auth)

28761 GAMMA DECAY OF ^{76}Se FOLLOWING THE β-DECAY OF ^{76}As. Paradellis, T.; Hontzeas, S. (Univ. of Saskatchewan, Regina, Can.). Nucl. Phys.; A142: 204-16(1970).

The γ-ray spectrum of ^{76}Se following the β-decay of ^{76}As is investigated. Thirty γ-rays are reported, most of them for the first time. Accurate energy measurements of the observed γ-rays and γ-γ coincidence data support a decay scheme for ^{76}Se which includes levels at 614.1 keV, 1308.8 keV, 1503.0 keV, 1854.6 keV, 1996.0 keV, 2328.6 keV, 2453.5 keV, 2508.0 keV, 2535.0 keV, 2681.5 keV, 2798.0 keV, 2838.3 keV, 3148.0 keV, 3296.0 keV, 3528.0 keV and 3718.0 keV. The log ft values for the branching to the excited levels of ^{76}Se support a spin 2^- assignment for the ^{76}As ground state, in agreement with the As systematics. (auth)

28762 ON THE STRUCTURE OF GIANT DIPOLE RESONANCE IN ^{32}S. Majling, L. (Nuclear Research Inst., Rez, Czech.); Rizek, J.; Bely, Yu. L.; Neudatchin, V. G.; Yudin, N. P. Nucl. Phys.; A143: 429-48(1970).

The photodisintegration of the ^{32}S nucleus is calculated in the framework of the microscopical model. The spread of the Fermi surface as well as particle and hole coupling with low-lying states is taken into account. The general features of the calculated absorption spectrum and different photonuclear reactions are discussed. An attempt is made to determine the origin of the peaks in the absorption spectrum on the basis of some reactions and calculated Coulomb form factors. Satisfactory agreement with experimental data is obtained. (auth)

28763 NEUTRON INDUCED NUCLEAR ISOMERISM IN ^{80}Br AT 2.5 AND 14.7 MeV. Cox, A. J.; Lucas, P. E. (Univ. of Aston, Birmingham, Eng.). J. Inorg. Nucl. Chem.; 32: 713-18 (Mar 1970).

The isomeric cross-section ratio was measured for ^{80}Br produced firstly by the ^{81}Br(n,2n)^{80}Br reaction with 14.7-MeV neutrons and secondly by the ^{79}Br(n,γ)^{80}Br reaction with 2.5-MeV neutrons. The accuracy of the measured results is enhanced by calculating the isomeric cross-section ratio entirely from the decay of the ground state of ^{80}Br. The results are compared to the predictions of the statistical model of nuclear reactions and it is found that both reactions produce a consistent value for the spin cut-off parameter, which determines the spin dependence of nuclear level densities. The isomeric cross-section ratio was found to be 1.21 ± 0.09 for the ^{81}Br(n,2n)^{80}Br reaction and 0.49 ± 0.02 for the ^{79}Br(n,γ)^{80}Br reaction. The value produced for the spin cut-off parameter is 2.7 ± 0.1. (auth) (UK)

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Refer also to abstracts 27101, 27106, 28416, 28467, 28653, 28654, 28684, 28695, 28696, 28698–28700, 28713, 28726, 28738, 28742, 28750, 28757, and 28759.

28764 (AAEC/TM-528) ENERGY BALANCE AT THE SCISSION POINT OF ^{236}U. Musgrove, A. R. de L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Jan 1970. 14p. Dep. CFSTI (U. S. Sales Only).

Deformation parameters are fitted to the average kinetic energy release data for thermal neutron fission of ^{235}U and the total deformation energy at scission is calculated. The internal excitation energy at the scission point is found by substraction from the calculated energy release and is found to be in disagreement with the requirements of the statistical theory of fission proposed by Fong (Phys. Rev. 102: 434). (Australia)

28765 (AERE-R-5341) THE ABSOLUTE STANDARDIZATION OF ^{133}Ba. Paske, R. E. A. (Atomic Energy Research Establishment, Harwell (England)). Jan 1970. 15p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

An X-γ coincidence method for the standardization of ^{133}Ba is described. The method involves coincidence counting between K- or L- X rays and a selection of the coincident γ rays. A correction factor to the normal coincidence equations is derived from the calculated probabilities of the occurrence of a single X-ray and a subsequent X-γ coincidence. Second order corrections are avoided in the experimental arrangement by the use of low geometry X-ray counting. The dependence of the results on possible variations in the decay scheme is evaluated. A comparison of results obtained using scintillation counters as X-ray and γ-ray detectors with those obtained using a solid state γ-ray detector showed good agreement. The latter approach simplifies data interpretation since a single γ-ray energy may be selected. (auth)

28766 (BNL-tr-318) CALCULATION OF THE SCATTERING OF FAST NEUTRONS ON ^{238}U. Buehler, F.; Schmidt, F. (Technische Hochschule, Stuttgart (West Germany)). Translated for Brookhaven National Lab., Upton, N. Y.), from report BMwF-FBK-67-90. 76p. Dep. CFSTI.

This item was previously abstracted from the original language and appeared in NSA as 22: 18204.

28767 (CONF-680461-7) DECAY STUDIES ON SHORT-LIVED NEUTRON-RICH NUCLIDES FROM (n,p) REACTIONS. Denig, R.; Herrmann, G.; Herzog, W.; Kaffrell, N.; Rosner, G.; Trautmann, N. (Mainz Univ. (West Germany). Institut fuer Anorganische Chemie und Kernchemie). [nd]. 24p. (In German). Dep.

From Professional Commission on Nuclear Physics, Bad Neuenahr, Germany.

Decay studies were made of the neutron-rich isotopes ^{96}Zr, ^{96m}Nb, ^{96}Nb, ^{99}Nb, ^{100}Nb, ^{113m}Ag, ^{114}Ag, ^{126}Sb, ^{128}Sb, ^{130}Sb, ^{154}Pm, ^{162}Tb, ^{163}Tb, ^{164}Tb, ^{235}Pa, ^{236}Pa, ^{237}Pa, and ^{238}Pa prepared by (n,p) reactions. The β and γ spectra obtained are given, and decay schemes are derived for ^{96m}Nb, ^{236}Pa, ^{162}Tb, ^{164}Tb, and ^{163}Tb. (J.S.R.)

28768 (CONF-690814-10) FRAGMENTATION PARAMETERS FOR NUCLEI IN THE CHARGE RANGE 48 ≤ Z ≤ 96. Turner, Robert E. (Washington Univ., St. Louis, Mo. Lab. for Space Physics). [1969]. 3p.

From 11th International Conference on Cosmic Rays, Budapest, Hungary.

Total and spallation cross sections are presented in a table of 25 nuclides having half-lives greater than 10^4 years. Restriction is made to relativistic particles and use is made of spallation cross sections determined from the radiochemical analysis of high-energy proton bombardment of uranium, thorium, bismuth, and lead. From the known fission cross sections of uranium, thorium, and bismuth as functions of energy the fissionability was determined and an empirical formula found for fission cross sections of other nuclides. An empirical formula was also derived from the known yield of fission products for ^{238}U to find the yields of other nuclides. (J.F.P.)

28769 (COO-1779-13) NUCLEAR CHEMISTRY RESEARCH. Annual Report for Calendar Year 1969. McHarris, Wm. C. (Michigan State Univ., East Lansing). Contract AT(11-1)-1779. 212p. Dep. CFSTI.

BISMUTH-205—beta and electron capture decay of, γ energies and intensities for, (E)
CYCLOTRONS—experimental facilities at Michigan State University, development of rabbit-pneumatic target
GAMMA SPECTROSCOPY—analysis and plotting methods in
IRON-53—beta and electron-capture decay of ground-state and isomeric, β and γ spectra from, (E)
LEAD-205—energy levels and transitions from bismuth-205 decay, (E)
MANGANESE-53—energy levels from iron-53 decay, (E)
PROMETHIUM-141—energy levels from samarium-141 decay, (E)
SAMARIUM-141—decay of ground-state and isomeric, γ spectra from, (E)
YTTERBIUM-167—beta and electron-capture decay of, γ spectra from, (E)
ZINC-62—beta and electron-capture decay of, γ spectra from, (E)

ZINC-63—beta and electron-capture decay of, γ spectra from, (E) (J.W.R.)

28770 (EURFNR-749) EVALUATED MICROSCOPIC NEUTRON CROSS SECTIONS AND 26 GROUP CONSTANTS FOR Cd. Bachmann, H.; Hinkelmann, B.; Krieg, B.; Langner, I.; Schmidt, J. J.; Siep, I.; Woll, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Nov 1969. 35p. (KFK-1080; EANDC(E)-125-U). Dep. CFSTI (U. S. Sales Only).

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Microscopic cross section data for Cd in the energy range 0.001 eV to 15 MeV recently incorporated in the Karlsruhe KEDAK file are described. The fast neutron cross sections were almost exclusively taken over from an evaluation by Drake from GGA with slight changes only in keV capture cross sections. In the thermal and resolved resonance energy ranges the neutron cross sections were recalculated from resonance parameters reevaluated with due account of more recent experimental information. The evaluated microscopic cross sections and resonance parameters have been transferred to and are available from the ENEA/CCDN. From the microscopic cross sections (unshielded) group cross sections in the 26 ABN group structure were calculated using both the neutron spectrum of a fast Na cooled prototype reactor and the neutron spectrum of the ABN group cross section set as weighting spectra. (auth)

28771 (INR-1142) EMISSION OF HYDROGEN AND HELIUM ISOTOPES IN THE FISSION OF ^{239}Pu; CLASSICAL MODEL OF THE TERNARY FISSION. Krogulski, Tadeusz (Institute of Nuclear Research, Warsaw (Poland)). 1969. 133p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The investigation of the ternary fission of ^{239}Pu induced by thermal neutrons is discussed. The measurements were performed using the telescope counter with semiconductor detectors. So is was possible to apply the two-parameter analysis to the investigated particles' energy, and hence to identify the kind of light isotopes accompanying fission. The relative yields of these isotopes and energy distributions were also measured. It was established that the fission of ^{239}Pu nuclei is accompanied by the emission of three hydrogen isotopes—protons, deuterons and tritons—and three helium isotopes—^{4}He, ^{6}He and ^{8}He. The Gaussian distributions were fitted to the measured spectra and the relative yields were calculated from the distribution extrapolated in this way. The comparison with analogous data on the spontaneous fission of ^{252}Cf and thermal neutron fission of ^{235}U reveals a pronounced similarity of the tripartition process irrespective of the nucleus involved. The energy distributions of the hydrogen and helium isotopes are almost identical, and the relative yields increase slightly, in the limits of 20%, with the number A of the fissioning nucleus. An analysis based on this result is undertaken to establish the extent to which it is possible to infer in a sufficiently univocal way, from the observed energy and angular distributions of hydrogen and helium isotopes, the scission configuration of the nucleus undergoing fission. It happens that the scissioning configurations could not be discriminated by considering only the energy spectra of light particles. However, this is possible taking into account the known angular distributions of the hydrogen and helium isotopes emitted in the spontaneous ternary fission of ^{252}Cf. The configuration chosen in this way is in agreement with the predictions of the liquid drop model. This result is discussed in terms of the predictions of the microscopic model regarding the saddle point deformation. (auth)

28772 (JINR-P6-4868) LEVELS OF ^{202}Po, ^{202}Po, ^{204}Po, ^{205}Po, ^{206}Po. Morek, T.; Broda, R.; Walus, W.; Droste, Ch.; Neubert, W.; Chojnacki, S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 28p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The levels of the odd and even polonium isotopes were investigated via the K-capture of $^{201-206}$At, produced in the reactions ^{197}Au(^{12}C,xn)$^{209-x}$At and ^{185}Re(^{22}Ne,xn)$^{207-x}$At, respectively. By means of γ-γ coincidence and integral conversion electron measurements level schemes are suggested. Prominent γ ray cascades were found in the even polonium isotopes ^{206}Po: 396 keV(E2), 476 keV(E2), 699 keV(E2); ^{204}Po: 426 keV(E2), 516 keV(E2), 682 keV(E2) and ^{202}Po: 443 keV, 571 keV, 676 keV. By analogy with the level structure in ^{208}Po and ^{210}Po these cascades are interpreted as transitions between the levels 6^+, 4^+, 2^+, 0^+ of the broken two quasiparticle multiplet $(h_{9/2})^2$. For the low excited states in ^{203}Po and ^{205}Po spin assignments are presented. (auth)

28773 (JINR-P6-4972) α DECAY OF ^{211}Rn AND ^{212}Rn. Afanas'ev, V. P.; Bochvarova, M.; Golovkov, N. A.; Gromova, I. I.; Ivanov, R. B.; Kuzin, V. I.; Norseev, Yu. V.; Chumin, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The α-decay of ^{211}Rn and ^{212}Rn was investigated using the magnetic spectrograph. Besides the known α-transitions of ^{211}Rn (5850 keV (1), 5783 keV (1.84), 5616 keV (0.08)) there were observed the new ones: 5466 keV ($4.1 \cdot 10^{-4}$), 5276 keV ($4.4 \cdot 10^{-4}$), 5179 keV ($8 \cdot 10^{-5}$) 5055 keV ($2 \cdot 10^{-5}$). The hindrance factors are presented. New levels: 391.4 keV, 585 keV, 684 keV are introduced for the ^{207}Po nucleus. For ^{212}Rn the 5588 keV ($5 \cdot 10^{-4}$) α-transition to the 687 keV level of ^{208}Po was observed. The parts of α-decay of ^{211}At, ^{211}Rn and ^{207}Po (41.3 ± 1.3%, 17.8 ± 1.3% and 0.028 ± 0.003%) are estimated. (auth)

28774 (KAPL-Trans-1) INTERFERENCE EFFECTS IN THE CROSS SECTION FOR THE RADIATIVE CAPTURE OF A NEUTRON BY A ^{149}Sm NUCLEUS. Kiripichnikov, I. V.; Ryndina, E. Z.; Urbanec, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). Translated by R. E. Slovacek (Knolls Atomic Power Lab., Schenectady, N. Y.), from report JINR-P15-4325. 12p. Dep. CFSTI.

This item was previously abstracted from the original language and appeared in NSA as 23: 25904.

28775 (LA-4174-TR) IDENTIFICATION AND NUCLEAR SPECTROSCOPY OF SEVERAL SHORT-LIVED FISSION PRODUCTS WITH AN ON-LINE MASS SEPARATOR. Eidens, J. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerper- und Neutronenphysik). Translated for Los Alamos Scientific Lab., N. Mex., from report NP-17528. 42p. Dep. CFSTI.

This item was previously abstracted from the original language and appeared in NSA as 22: 46732.

28776 (LA-4176-tr) INVESTIGATION OF MASS AND TIME DISTRIBUTION OF DELAYED NEUTRONS IN THE THERMAL FISSION OF ^{235}U BY AN ON-LINE MASS SEPARATOR. Roecki, E. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerper-und Neutronenphysik). Translated for Los Alamos Scientific Lab., N. Mex., from German report. 40p. Dep. CFSTI.

The delayed neutron emission in the thermal fission of ^{235}U was investigated with a helium-filled mass separator. The neutron activity was measured in coincidence with the β decay arising from neutron emission. From the measurement of the activity buildup, the neutron yield for various times after fission was determined, and the half-life was obtained from the measurement of the activity decay. The mass distribution of these magnitudes was determined in the total fission yield range. The total neutron yield of light fission products is 1.05 neutrons/100 fissions, and that of heavy fission products is only 0.53 neutrons/100 fissions. The measured mass and time dependence were compared with the previously published values for identified neutron emitters. Previously unidentified fractions of the activity in the mass range from 85 to 88 (half-life of 1 sec) and the mass range from 96 to 100 (half-life of 1.5 sec) are discussed. The yield variation between light and heavy fission products is indicated on the basis of the systematics of the delayed neutron emission, and the previously unidentified activity was assigned to the mother nuclides ^{98}Y and ^{99}Y. (auth)

28777 (LYCEN-6954) HYPERFINE INTERACTION STUDY BY ANGULAR CORRELATIONS. Marest, Gilbert (Lyon Univ. (France). Institut de Physique Nucleaire). Dec 1969. 91p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

Static magnetic and electric hyperfine interactions and time-dependent interactions were studied by measuring perturbed angular correlations through integral and differential methods. A few applications of hyperfine interactions to nuclear and solid state physics were considered. Thus, magnetic moments of the first excited states of ^{192}Os, ^{192}Pt and ^{196}Pt, and the second excited state of ^{192}Pt were determined. Then measurements of perturbed angular correlations of the 133-142 keV cascade of ^{181}Ta were performed; the effects of resolution time on these measurements were studied, and a quadrupole perturbation in a Hf O_2 source was discovered. An effect subsequent to the (n,γ) reaction in a polycrystalline complex of hafnium acetylacetonate was revealed. By measuring angular correlations in the decay of ^{169}Tm excited levels, static electric quadrupole and time depending magnetic dipole interactions were studied in a Yb-Ag compound. (France)

28778 (NP-18191) A 31 ms ISOMERIC ACTIVITY IN ^{155}Gd. Liukkonen, E.; Pursiheimo, V.; Tuurnala, T. (Helsinki Univ. (Finland). Dept. of Physics). Jan 1969. 12p. Dep. CFSTI (U. S. Sales Only).

A 31 ± 2 ms isomeric activity which is assigned to ^{155}Gd was

produced through the reaction $^{154}Gd(n,2n)^{153}Gd$ with 14–15 MeV neutrons. The 31 ms activity contains Gd K X-rays and an 86.5 keV E1-transition, which corresponds to a well-known E1-transition depopulating the 86.5 keV level in ^{155}Gd. Most probable candidates for the isomeric state in ^{155}Gd lie at 105 keV ($^{9}/_{2}^{+}$) and at 118 keV ($^{11}/_{2}^{-}$). (auth)

28779 (ORNL–4457) THE ABSOLUTE SPECTRUM OF PHOTONS EMITTED IN COINCIDENCE WITH THERMAL-NEUTRON FISSION OF ^{235}U. Peelle, R. W.; Maienschein, F. C. (Oak Ridge National Lab., Tenn.). Apr 1970. Contract W-7405-eng-26. 101p. Dep. CFSTI.

Data obtained earlier were fully analyzed to yield the absolute energy spectrum of prompt photons emitted from the fission of ^{235}U by thermal neutrons. In the measurement, each of three types of NaI(Tl) scintillation spectrometers (single-crystal, Compton, and pair) was operated in coincidence with a fission chamber exposed to thermal neutrons from the Oak Ridge Graphite Reactor or the Bulk Shielding Reactor at the Oak Ridge National Laboratory. The effective coincidence resolving time was ≤69 nsec. Detailed and careful construction of the response functions of the spectrometer was based on their exposure to radioactive sources of known disintegration rates. These data were used to "unfold" the measured pulse-height spectra to give the absolute differential energy spectrum and uncertainty. The average number of photons per fission was 8.13 ± 0.35 and the energy release per fission was 7.25 ± 0.26 MeV, both over the energy region from 10 keV to 10.5 MeV. Output spectra are given with an effective resolution only slightly broader than the inherent energy resolution of the spectrometers except at energies above 5 MeV, where the raw pulse-height bins were made wider than the spectrometer resolution to reduce statistical uncertainties. Combinations of the data into four sets of coarser energy groups are also included to simplify use of these data in computations. The results obtained here are in approximate agreement with the measurement of Verbinski et al., in the energy region above 100 keV. From 1.5 to 4 MeV the calculation of Zommer et al., gives results which are surprisingly close to the measurements. The observed total energy release in photon emission per fission is predicted reasonably closely by the Thomas and Grover calculation which takes into account the large angular momentum of the fission fragments. (auth)

28780 (ORNL-tr–2226) THE DECAY OF ^{180}Ta. PART II. Eberhardt, P.; Signer, P.; Herr, W.; Merz, E. Translated by Lynda H. Kern (Oak Ridge National Lab., Tenn.), from Z. Naturforsch.; 13A: 1004(1958). 3p. Dep. CFSTI.

An analysis of K-capture decay of tantalum-180 is carried out using tantalite mineral. From this analysis the upper limit for the decay constant of K-capture was found to be $\lambda_K = 1.5(10)^{-19}$ years. (J.F.P.)

28781 (SGAE–PH–89/1969) MEASUREMENT OF THE FORWARD-BACKWARD ASYMMETRY IN ^{203}Hg. Woda, Helmut (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). 1969. 69p. (In German). Dep. CFSTI (U. S. Sales Only).

Thesis.

A parity impurity of a nuclear state should lead to a small forward-backward-asymmetry of the β–γ angular correlation. An attempt to measure this asymmetry in ^{203}Hg is described. Because of the source strength necessary, which results in a chance rate equal to the real coincidence rate, a special method was developed for the simultaneous measurement of the chance coincidences. In addition, this method greatly reduces the necessary corrections. Several distortions because of the complexity of the decay $^{203}Hg(\beta,\gamma)^{203}Tl$ were determined and the necessary corrections calculated. The measured asymmetry was $A = (3.1 \pm 0.56) \times 10^{-3}$, of the same order of magnitude as calculated for multiple scattering of Compton quanta in the γ-detector. An additional measurement with a back scattering foil (Au) to reverse the direction of electrons emitted at $\theta = 180°$ gave no significant difference. The initial theoretical estimate was revised according to recent measurements; if one takes Lobashov's value $F = 2 \times 10^{-7}$, one arrives at a predicted asymmetry of $A \approx -1.7 \times 10^{-6}$. (auth)

28782 (UUIP–660) PERTURBATIONS OF THE ALPHA–GAMMA ANGULAR CORRELATION IN THE DECAY OF ^{224}Ra. Orre, B.; Linnfors, A.; Falk, F.; Thun, J. E.; Johansson, L. (Uppsala Univ. (Sweden). Inst. of Physics). Dec 1969. 40p. Dep. CFSTI (U. S. Sales Only).

The gyromagnetic ratio for the first excited (2+) rotational state (185.7 keV, $T_{\frac{1}{2}} = 0.32$ ns) of ^{220}Rn was obtained by the technique of perturbed α–γ angular correlations. The result $g_R = 0.26 \pm 0.04$ is below Z/A. The average internal magnetic field of radon atoms recoiling into nickel was determined to be 15 ± 3 kilogauss and positive. The perturbations in different environments were studied by observing the coincidence rate in 180° between α and γ. In vacuum the perturbations were severe but could be decoupled in a parallel magnetic field. A number of solids were examined and the perturbations were in general small. In all measurements thin sources were used. The thickness of one typical source was deduced from the energy loss of alpha particles. (auth) (SW)

28783 K-SHELL AUTO-IONIZATION IN THE BETA DECAY OF ^{210}Bi. Campbell, J. L. (Univ. of Guelph, Ont.). Phys. Lett.; 31B: 563–4(27 Apr 1970).

A value $P_K = (1.25 \pm 0.08) \times 10^{-4}$ was obtained for the auto-ionization probability in the β^- decay of ^{210}Bi, in a measurement that did not involve β^- counting. The result lies between the values calculated from hydrogenic and Hartree–Fock–Slater wave functions. (auth)

28784 NUCLEAR MAGNETIC MOMENT OF ^{203}Hg BY OPTICAL PUMPING. King, R. L. (New York Univ., N. Y.); Liu, C. H.; Stroke, H. H.; Redi, O. Phys. Lett.; 31B: 567–9(27 Apr 1970).

Optical-pumping techniques were used to obtain a direct measurement of the nuclear magnetic moment of the 47-d radioisotope ^{203}Hg. The result is $(^{203}\mu)_{uncorrected} = 0.83549(13)\mu_N$. The effect of distributed nuclear magnetization gives an hfs anomaly $^{203}\Delta^{201} = 0.0064(2)$. (auth)

28785 ANGULAR CORRELATION METHOD TO TEST PARITY VIOLATION IN ^{203}Tl. Baker, K. D.; Hamilton, W. D. (Univ. of Sussex, Brighton, Eng.). Phys. Lett.; 31B: 557–9 (27 Apr 1970).

A novel angular correlation method possessing an inherently high degree of accuracy was used to search for an odd Legendre term in a β–γ correlation. Such a term is indicative of a parity violating component in the electromagnetic transition. The β–γ cascade following the decay of ^{203}Hg was used and this gave an asymmetry $A_1 = (6 \pm 8) \times 10^{-5}$. This indicates that the amplitude of the irregular parity admixture is $< 6.6 \times 10^{-7}$ which is consistent with other independent experimental measurements and with theory. (auth)

28786 PRESENT STATUS OF THE PHYSICAL KNOWLEDGE OF THE MOST IMPORTANT REACTOR NUCLEAR DATA. Schmidt, J. J. (Kernforschungszentrum, Karlsruhe, Ger.). Atomkernenergie; 15: 26–34(1970). (CONF-690419–12).

From Reactor Meeting of the German Atomforum, Frankfurt am Main, Germany.

It is illustrated that unfortunately there are still discrepancies in the most important microscopic data information for fissionable and fertile nuclei but also, that, in the cross section knowledge and in the physical understanding of the cross section behavior, particularly in the fission of ^{239}Pu, considerable progress has been achieved. In almost all cases the phase of pioneering measurements is passed and has gone over into a phase of careful measurements for clarification of discrepancies and for far more detailed comparisons of different measurements. A series of such measurements is still underway. In this context it might be particularly useful to mention the measurements of Pfletschinger and Käppeler at Karlsruhe and the comprehensive measurement program of Pönitz at Argonne for the fission cross sections. Furthermore the systematic testing of microscopic data used in reactor calculations by comparison with the results of integral experiments still increases in importance and substance. Finally, on the basis of the results so far achieved, of the extensive international efforts in measurement and evaluation of nuclear data and of the increasing comparisons with reactor experiments, one might dare the cautious prognosis, that for the most important fissionable and fertile materials by the end of 1969 some of the mentioned discrepancies will have been clarified and, that by the end of 1970 at least for these materials which are most important for the calculation and prediction of the properties of fast power reactors, a reliable data basis will have been established. (auth)

28787 ON THE DECAY OF ^{140}Ba TO ^{140}La. Kern, Jean; Mauron, Gabriel (Univ., Fribourg, Switzerland). Helv. Phys. Acta; 43: 272–8(15 May 1970).

To complement results obtained by (d,p) and (n,γ) reaction spectroscopy on the structure of ^{140}La, some details of the decay of ^{140}Ba were investigated using a Ge(Li) detector. Several γ-ray energies and intensities were determined with improved accuracy. In addition, upper limits were obtained for transitions which are important to the test of the nuclear model describing ^{140}La. (auth)

28788 GAMMA RADIATION EMITTED IN ^{188}In DECAY. Rivier, Janine; Moret, Roger (Grenoble Univ., France). Compt. Rend., Ser. B; 270: 291–3(26 Jan 1970). (In French).

New transitions were discovered in ^{109}In decay, using a Ge(Li) detector. Energies and intensities of all the new transitions are given. (auth) (France)

28789 DECAY OF ^{143}Sm AND ^{143}Sm. Hayashibe, Syogo; Yoshikawa, Nobuharu (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 1, 64-72(Jun 1969). (In Japanese).

Sm_2O_3 of enriched ^{144}Sm (75%) was irradiated with γ-ray of max. energy 40 and 60 MeV, to investigate the decay of ^{143}Sm and ^{143}Sm. ^{143}Sm was produced by the reaction ^{144}Sm(γ,n)^{143}Sm. Discrimination of ^{143}Sm from other nuclides was relatively easy because of its short half-life. The γ-ray spectrum accompanying the decay was measured with a 36 cc. Ge(Li) detector. Decay curves for the peaks in the spectrum are shown. γ-rays with energy 1058, 1516, 1174, 1404, or 1245 keV, were identified as belonging to the decay of ^{143}Sm. The possible existence of an intense γ-ray with lower energy was suggested from the analysis, so that the composition of the decay scheme of ^{143}Sm was postponed. For ^{143}Sm, the results of previous measurements were ascertained in this experiment. The spin and parity of the ground state of ^{143}Pm were concluded to be 1^+. (NSA of Japan)

28790 LEVEL SCHEME OF ^{223}Ra. 1. GAMMA RAYS EMITTED IN DECAY ^{227}Th → ^{223}Ra. Briancon, Chantal; Walen, Robert. (Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse, Orsay, France). J. Phys. (Paris); 30: 753-61(Oct 1969). (In French).

Gamma transitions in ^{223}Ra were studied with Ge-Li diodes using different ways of purification in order to minimize the influence of the six radioactive daughter products. About 180 of the observed transitions have been introduced in the decay scheme. (auth)

28791 NEUTRON CROSS SECTIONS OF CADMIUM ISOTOPES. Vertebnyi, V. P.; Vlasov, M. F.; Gnidak, N. L.; Grishanin, E. L.; Dadakina, A. F.; Zatserkovskii, R. A.; Kirilyuk, A. L.; Lependin, V. I.; Pasechnik, M. V.; Trofimova, N. A. At. Energ. (USSR); 27: 349(Oct 1969). (In Russian).

In connection with the problem of absorber-burnout in the VVR-M reactor, the total neutron cross section and the scattering cross section of ^{111,112,114,116}Cd were measured. In order to burn the strongly absorbing ^{113}Cd, the specimens were irradiated in the beryllium reflector of the reactor at a flux of 4.3×10^{20} neutrons/cm^2. A chopper with a resolution of 6 μsec/m was used for the measurements. The scattering cross section was determined in a 4π geometry in the 0.3 to 9 eV range. It was found that ^{112}Cd, $\sigma_s < 1$ barn and $\sigma_a^{2200\,m/sec} \leq 0.5$ barn. For ^{116}Cd, $\sigma_t \cong \sigma_s$ and $\sigma_a^{2200\,m/sec} \leq 2.5$ barn. The capture cross section of ^{111}Cd at V = 2200 m/sec was found to be 7.7 ± 0.8 barn; that of ^{114}Cd was 6.9 ± 0.7 barn. The scattering cross section σ_s of ^{111,112,114,116}Cd and natural cadmium were found to be 5.2 ± 0.3, 6.9 ± 0.3, 5.2 ± 0.3, 6.3 ± 0.3, and 5.6 ± 0.3 barn, respectively. The concentration of ^{113}Cd was estimated at $\sim 5 \times 10^{-3}$%. (TTT)

28792 NUCLEAR-CHEMISTRY STUDIES IN PHOTONUCLEAR REACTIONS. Kajhi, Harumi; Takita, Yujhi (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 1, 141-2(Jun 1969). (In Japanese).

Nuclear-chemistry experiments were performed concerning the fission-produced nuclei from ^{209}Bi due to high-energy gamma-ray irradiation. The objectives were the shielded-nucleus ^{134}Cs and the quasi shielded-nucleus ^{95}Nb, whose cross sections for nuclear isomers were obtainable. Bismuth of 99.9999% purity, was irradiated with bremsstrahlung of energy 250, 200 and 150 MeV for about two hours; 0.6-mm tantalum was used as the converter. It took about 20 minutes to separate Cs, and the chemical yield was 88 to 90%; for the separation of Nb, it took 1 hour, and the yield was about 90%. The cross-section ratio of nuclear isomers for ^{134}Cs and ^{95}Nb, obtained in the experiments, are also given. (NSA of Japan)

28793 ELECTROMAGNETIC LIFETIMES. Warburton, E. K. (Brookhaven National Lab., Upton, N. Y.). pp 43-74 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

The importance of nuclear lifetime measurements for evaluating nuclear wave functions is discussed. Some examples of comparisons of measured electromagnetic matrix elements to nuclear model predictions are presented. Advances in experimental techniques concerning the methods of recoil distance, Doppler shift attenuation, electronic timing, and capture cross sections to virtual states are described. (J.W.R.)

28794 MOESSBAUER STUDIES WITH VAN DE GRAAFF ACCELERATORS. Walker, J. C.; Lee, Y. K. (Johns Hopkins Univ., Baltimore). pp 131-40 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

The use of low energy accelerators for excitation of nuclear levels whose decays can show Moessbauer effects is discussed. The application of these techniques to determinations of nuclear moments of several even isotopes of ytterbium is mentioned. A brief discussion of initial experiments to observed Moessbauer effects in ^{238}U is given. (auth)

28795 THE 3.8-MIN. ISOMER OF ^{134}I. Carraz, Louis-Claude; Blachot, Jean; Monnand, Edouard; Moussa, Andre (CEA, Grenoble, France). Compt. Rend., Ser. B; 270: 358-61(2 Feb 1970). (In French).

It was established that a 3.8-min isomer of ^{134}I is produced in the fission of ^{235}U by thermal neutrons. The value of its spin is probably high. It is not produced by the β^- decay of ^{134}Tc. It emits two γ radiations of 44.5 and 271.5 keV. (auth) (France)

28796 CHARGE DISPERSION STUDIES IN THE FISSION OF ^{239}Pu BY PROTONS OF MEDIUM ENERGY. Saha, G. B.; Yaffe, L. (McGill Univ., Montreal). J. Inorg. Nucl. Chem.; 32: 745-67(Mar 1970).

The independent formation cross sections of ^{129}Cs, ^{130}Cs, ^{131}Cs, ^{132}Cs, ^{134m}Cs, $^{134m+g}$Cs, ^{136}Cs, and ^{138}Cs and the cumulative yield of ^{138}Xe produced in the fission of ^{239}Pu by protons of energies 20 to 85 MeV were determined by radiochemical methods. The excitation functions of the neutron-deficient products increased with increasing bombarding energy, whereas those of the neutron-rich products showed maxima in this energy range. The cross sections were used to construct charge dispersion curves. As the bombarding energy increases, the charge dispersion curve becomes broader and the most probable charge, Z_p, shifts towards β-stability. The full-widths at half-maximum of the dispersion curves, and the displacement of Z_p from β-stability ($Z_A - Z_p$) were compared with the published data for other targets, and a correlation with the neutron-to-proton ratio in the target was established. Calculations of Z_p were made, based on the unchanged charge distribution and equal charge displacement hypotheses. The results, although not definitive, favor the former hypothesis. The total number of neutrons, ν_T, emitted in fission was estimated. (auth)

28797 STABILITY OF HEAVY NUCLEI AND THE LIMITS OF THE PERIODIC SYSTEM OF ELEMENTS. Flerov, G. N.; Druin, V. A.; Pleve, A. A. (Joint Inst. of Nuclear Research, Dubna, USSR). Usp. Fiz. Nauk; 100: 45-92(Jan 1970). (In Russian).

A brief review is given on the stability of heavy nuclei and on the relation between the nuclear structure and the probability of fission. The article covers the methods of synthesis, separation, and identification of transfermium elements. High-sensitivity, high-speed physical and chemical analyses used in studies of new elements (102, 103, 104, and 105) are described. The history of the discovery, synthesis, systematics, fission, and properties of the 102, 103, 104 (Kurchatovium), and 105 elements are reviewed as well as the attempts at finding element 114 and the search for super-heavy nuclei in cosmic rays and earth core. 148 references are included. (R.V.J.)

28798 THE DECAY OF ^{184g}Re AND ^{184m}Re. Kukoc, A. H.; Singh, B.; King, J. D.; Taylor, H. W. (Univ. of Toronto). Nucl. Phys.; A143: 545-61(1970).

A total of 24 gamma rays were observed accompanying the decay of the 38 d ground state of ^{184}Re and the 169 d isomeric state. Three of these gamma rays have not been reported previously. A level scheme is proposed for ^{184}W with levels at 111.1, 364.3, 748.3, 903.1, 1005.9, 1121.3, 1130, 1133.8, 1221.4, 1285.2, 1386.2 and 1501.6 keV. The ratios of the reduced E2 transition probabilities are calculated for several pairs of transitions. (auth)

28799 INTENSITIES OF THE PARTIAL RADIATIVE TRANSITIONS TO THE ROTATIONAL AND VIBRATIONAL BANDS IN THE RESONANCES OF THE ^{155}Gd AND ^{157}Gd ISOTOPES. Danelyan, L. S.; Efimov, B. V.; Sotnikov, S. K. Zh. Eksp. Teor. Fiz.; 58: 456-9(Feb 1970). (In Russian).

The total intensities of γ-transitions to the rotational and vibrational band levels in the ^{155}Gd and ^{157}Gd resonances for neutron energies up to 150 eV were measured with a double-crystal scintillation spectrometer. An analysis of the experimental data indicates the existence of correlation between the intensities of transitions to the rotational band and the spins of the initial states in the ^{155}Gd nucleus. A probability assignment of capture state spins of ^{155}Gd was made. (auth)

28800 HIGH-ENERGY PHOTOFISSION IN ^{238}U, ^{232}Th, AND ^{209}Bi. Schroeder, Bent; Nydahl, Goeran (Univ. of Lund, Sweden). Nucl. Phys.; A143: 449-67(1970).

The mass-yield distributions from photofission of ^{238}U and ^{232}Th at 300 to 1100 MeV and of ^{209}Bi at 700 MeV were measured using catcher-foil techniques combined with gamma-ray spectroscopy. The cross sections of symmetric and asymmetric photofission in uranium and thorium have been calculated from the peak-to-valley ratios. The experimental results were used to work out a qualitative model for high-energy photofission in heavy elements. (auth)

28801 DECAY $^{177}W \rightarrow {}^{177}Ta$. Nadjakov, E.; Kutsarova, T.; Bochev, B.; Pfrepper, G.; Raichev, H. (Inst. of Physics, Sofia. Joint Inst. for Nuclear Research, Dubna, USSR). Compt. Rend. Acad. Bulg. Sci.; 22: 1225-8(1969).

Data obtained on the ^{177}W decay with a Ge(Li) gamma spectrometer are discussed. Tables of transition energies, relative intensities of K-conversion lines, relative intensities of gamma lines, internal K-conversion coefficients, and multipolarity assignments are presented. The data are compared with that from other sources. (L.W.A.)

28802 EXISTENCE OF SUPER-HEAVY NUCLEI. Bhattacharjee, S. K. (Tata Inst. of Fundamental Research, Bombay). pp 9-11 of Nuclear Physics Symposium, Calcutta, July 15-19, 1969. /Baliga, B. B. (ed.). Calcutta; Saha Inst. of Nuclear Physics (1969).

See CONF-690716.

Predictions about the fission properties of a superheavy nucleus Z = 114 and experimental efforts investigating the production of such an element in the laboratory are presented. Efforts to find the element in nature are also discussed. (L.W.A.)

28803 SPECTRA OF INTERNAL CONVERSION ELECTRONS IN ^{173}Lu. Kartashov, V. M.; Kiselev, B. G.; Troitskaya, A. G.; Shevelev, G. A. (Inst. of Nuclear Physics, Alma-Ata, SSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 2068-73(Dec 1969). (In Russian).

Internal conversion electron spectra for ^{173}Lu were studied using a magnetic $\pi\sqrt{2}$ β spectrometer with a resolving power from 0.28 to 0.08%. Multiple spectrum measurements for fixed geometry revealed that conversion lines of the more intense transitions of ^{173}Yb are represented by overlapping lines with intensities varying with time. The energies and multipolarities of transitions in ^{173}Yb were verified. Internal conversion coefficients in the K-shell for the transitions were determined. Data obtained were correlated to published data. (R.V.J.)

28804 PHOTONEUTRON CROSS SECTION FOR SILVER ISOTOPES. Ishkhanov, B. S.; Kapitonov, I. M.; Lazutin, E. V.; Piskarev, I. M.; Shevchenko, O. P. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 2074-7(Dec 1969). (In Russian).

Cross sections of photoneutron formation on ^{107}Ag and ^{109}Ag in the region of the giant dipole resonance were measured with a 35-MeV betatron. Measurements were made at 7 to 30 MeV at 100-keV intervals. Total photoneutron cross sections are given in graphical form, and energy positions of maxima in MeV are tabulated. The integral cross sections obtained were compared with published data. (R.V.J.)

28805 PROBABILITIES OF ELECTROMAGNETIC TRANSITIONS BETWEEN EXCITED STATES IN ODD NUCLEI. Konstantinov, B. D. (Inst. of Physics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 2078-82(Dec 1969). (In Russian).

Probabilities of β(E2) and β(M1) transitions between the lowest states of odd-parity nuclei in the region close to the equidistant spectrum were estimated. Studies were based on the nuclear model of an even-even core and external nucleon which interacts with the core surface. Data obtained for the M1 and E2 transition probabilities for ^{63}Cu, ^{137}Ba, ^{199}Hg, $^{203,205}Tl$, and ^{207}Pb were in good agreement with experimental data. (R.V.J.)

28806 POSSIBLE EXISTENCE OF SUPERHEAVY ELEMENTS IN NATURE. Vdovenko, V. M.; Sobotovich, E. V. Dokl. Akad. Nauk SSSR; 189: 980-3(11 Dec 1969). (In Russian).

A table based on the data of Nilsson is presented with the maximum half-lives of superheavy elements having atomic numbers from 106 to 116 and having 178 to 189 neutrons. At least 18 isotopes have half-lives greater than 10^8 years. The longest half-life of 10^{16} years is predicted for EKA-lead with a mass of 298 (Z = 114). It is assumed that superheavy elements have been continuously interacting with the earth's atmosphere and then settling on the earth's surface. An average heavy-element distribution of 2×10^{-21} g/g of earth's crust is calculated. A search for the superheavy elements in natural deposits is proposed. The superheavy elements, their maximum half-lives, the elements with which they would be associated, and the relative difficulty of the search are tabulated. Possible searches in various sulfide deposits appear to be promising. Some industrial processes may serve as a point of departure, for example, distillates of lead. It may be possible to find ekaradon (half-life of 10^3 years) associated with the Ar, Kr and Xe residues from liquid-oxygen or liquid-air plants. Aerosols which have settled out on glaciers, it is estimated, may contain 900 atoms of superheavy isotopes per 1 m^2 of ice, and searches could be conducted on glacial material. Meteoric material may also serve as a source of superheavy elements. (TTT)

28807 RESONANCE SELF-SHIELDING FACTORS FOR HEAVY ACTINIDES. Patterson, R. M.; Christman, R. P.; Hennelly, E. J. Contract AT(07-2)-1. J. Nucl. Energy; 24: 53-6(Feb 1970).

An empirical method was developed for making useful predictions of resonance self-shielding of heavy element nuclides for which differential cross section data are limited or unknown. The technique is also applicable for rapid "hand" calculations of effective resonance integrals for nuclides for which cross section data are available. The method applies nuclear systematics to calculate the effective resonance integral, RI_{eff}, from the total infinitely dilute resonance integral, RI_{∞}, as a function of number density. (auth) (UK)

28808 MEASUREMENTS OF THE g-FACTORS OF THE EXCITED STATES $11/2$ IN ^{147}Eu AND ^{149}Eu NUCLEI. Klimentovskaya, M. V.; Lebedev, N. A.; Sorokin, A. A. (Moscow State Univ. Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 2053-5(Dec 1969). (In Russian).

Rotation functions for angular correlation of cascades $9/2^-$(1) $11/2^-$ (2) $7/2^+$ in ^{147}Eu (370-396 keV) and ^{149}Eu (299-346 keV), excited during the decay of ^{147}Gd and ^{149}Gd in an external magnetic field, were measured. The g-factors obtained for the $11/2^-$ levels in ^{147}Eu (625 keV) and ^{149}Eu (497 keV) were +(1.38 ± 0.25) and +(1.31 ± 0.25), respectively, which are close to the Schmidt magnitudes (±1.42) for the state $h_{11/2}$ in odd-proton nuclei. (R.V.J.)

28809 GAMMA RAYS FROM ^{147}Gd. Avotina, M. P.; Grigor'ev, E. P.; Zolotavin, A. V.; Sergeev, V. O.; Arl't, R.; Muziol, G.; Shtrusnyi, Kh. (Leningrad State Univ. Joint Inst. for Nuclear Research, Dubna, USSR.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 33: 2042-52(Dec 1969). (In Russian).

A gamma spectrometer with a Ge(Li) detector (with resolving power of 4.5 keV at an energy of 1 MeV) was used for measuring the γ spectrum of ^{147}Gd. The experiments revealed 20 new γ transitions. An energy level scheme for ^{147}Eu was developed. (R.V.J.)

28810 NEUTRON CAPTURE CROSS SECTIONS OF CERIUM AND THALLIUM IN THE keV REGION. Kompe, D.; Ernst, A.; Froehner, F. H. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys.; A141: 602-8(1970).

The neutron capture cross sections of natural cerium and thallium were measured between 10 and 200 keV. The time-of-flight method was used, with a pulsed Van de Graaff accelerator providing the neutron source and with a large liquid scintillator detector. The measured cross sections are extremely low owing to the near-magic nucleon numbers of Ce and Tl. They were averaged over Maxwellian velocity distributions with kT values between 10 and 100 keV so as to be useful for calculations of nucleosynthesis in stars. (auth)

28811 THE ^{205}Tl LEVEL SCHEME AS INVESTIGATED BY NUCLEAR RESONANT SCATTERING OF 7646 keV γ-RAYS. Cesareo, R.; Giannini, M.; Oliva, P. R.; Prosperi, D.; Ramorino, M. C. (CNEN, Rome). Nucl. Phys.; A141: 561-76(1970).

Monochromatic photons with energy 7646 keV produced by thermal neutron capture in iron resonantly excite a ^{205}Tl level, with spin $1/2$. The scattering isotope was identified by coincidence measurements. From the study of the primary inelastic photons deexciting the resonant level, 16 new levels were observed, between 1300 and 3300 keV, in addition to 7 previously known. The ^{205}Tl level scheme is discussed and compared with theoretical predictions. (auth)

28812 ABSOLUTE PHOTOELECTRIC CROSS SECTIONS OF 800-keV GAMMA RAYS. Raja Rao, M.; Parthasaradhi, K.; Jnanananda, Swami (Andhra Univ., Waltair, India). Indian J. Phys.; 43: 300(May 1969).

The measurement of the absolute photoelectric cross-sections of 800 keV gamma rays in Au and Ta using a plastic phosphor scintillation detector and the internal external conversion tech-

nique is briefly discussed. The experimental total photoelectric cross-sections (in barns per atom) of 8.3 ± 1.0 for Au and 5.3 ± 0.6 for Ta are compared to the corresponding theoretical values—8.3 and 5.6—of Schmickley and Pratt. (L.W.A.)

28813 K-CONVERSION COEFFICIENT OF THE 412-keV TRANSITION IN ^{198}Hg. Sahota, H. S.; Sood, B. S. (Punjab Univ., Patiala, India). Indian J. Phys.; 43: 296-7(May 1969).

The determination of the internal conversion coefficient for the 412-keV transition in ^{198}Hg is presented. Gold-198, which emits K-shell x rays due to the internal conversion in ^{198}Hg and 412 keV x-rays, is used as the target for 662-keV gamma rays from ^{137}Cs source. The ratio of K-x rays and Compton scattered gamma rays (^{137}Cs source and gold target) is used to calculate the K-conversion coefficient for the 412-keV transition in ^{198}Hg. Coefficient values obtained through other methods are compared in tabular form. (L.W.A.)

28814 MATRIX ELEMENT DETERMINATIONS FOR HINDERED BETA TRANSITIONS IN ^{124}Sb AND ^{160}Tb. Cipolla, S. J.; Steffen, R. M. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; A143: 404-28(1970).

Beta-gamma directional correlation measurements as a function of beta-energy were made on the cascades β(1.590)-γ(0.722) and β(1.667)-γ(0.645) in the decay of ^{124}Sb and on the cascades β(1.750)-γ(0.087) and β(1.540)-γ(0.197) in the decay of ^{160}Tb. A high-resolution Ge(Li) gamma detector was used, providing a significant improvement in the accuracy of the measurements. The data and the ft values are used to determine the nuclear matrix elements for the 1.590-MeV beta transition and for the 1.750-MeV beta transition. In each case, two sets of matrix elements were found to fit the data well, and arguments based on the CVC theory and nuclear models are used to select the best set. The matrix elements are compared with those measured for hindered beta transitions in other nuclei. The matrix element analyses of the 1.667 MeV transition in ^{124}Sb and the 1.540 MeV transition in ^{160}Tb both met with difficulties. (auth)

28815 THE EXISTENCE OF AN UNKNOWN NATURAL α ACTIVITY IN THE 4.3 TO 4.6 MeV REGION. Meier, H.; Albrecht, W.; Boesche, D.; Hecker, W.; Menge, P.; Ruckdeschel, A.; Unger, E.; Zeitler, G.; Zimmerhackl, E. (Staatliches Forschungsinstitut fuer Geochemie, Bamberg, Ger.). Z. Naturforsch.; 25a: 79-87(Jan 1970). (In German).

Osmium-iridium samples of various origin showed, aside from radionuclides of natural decay series, α activity with an energy range from 4.3 to 4.6 MeV and γ radiation with a peak at 200 to 220 keV. These radiations could not be assigned to any of the known radionuclides. The possibility that enhanced amounts of ^{235}U or ^{239}Pu in geologic samples could lead to production of transuranium elements above the atomic number 96 was discussed. Also discussed was the possibility that the activity originated from naturally present superheavy elements of the Ekaplatinum group. (tr-auth)

Nuclear Theory

Refer also to abstracts 28189, 28625, 28633, 28693, 28695, 28696, 28699, 28717, and 28757.

28816 (AAEC/TM-524) COMPOST: AN OPTICAL MODEL CODE FOR ELASTIC AND INELASTIC SCATTERING. Bertram, W. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Nov 1969. 14p. Dep. CFSTI (U. S. Sales Only).

A description is given of the optical code COMPOST which calculates the elastic and inelastic scattering cross sections of charged or neutral particles with either spin 0 or spin ½. The optical potential can either be of the local type or the nonlocal type and may include spin-orbit coupling. (auth)

28817 (BMBW-FBK-69-42) STUDIES IN THE CLUSTER MODEL OF THE ATOMIC NUCLEUS BY METHODS OF GROUP THEORY. Seligman, T. H. (Tuebingen Univ. (West Germany). Institut fuer Theoretische Physik). Dec 1969. 94p. (In German). Dep. CFSTI (U. S. Sales Only). ZAED.

The group-theoretical properties of the nuclear cluster model are investigated. The symmetric group proves to be especially important. The consideration of permutational symmetry in the cluster ansatz shows that there is a close relation between this ansatz and the Wigner supermultiplet scheme. The antimetrization is simplified in a systematic way. The coefficients appearing in the procedure are calculated from the representations of the symmetric group. (auth)

28818 (BNL-50199) MOGUS: A CODE FOR EVALUATING THE MOTT SCATTERING CROSS SECTION AND THE GOUDSMIT-SAUNDERSON ANGULAR MULTIPLE-SCATTERING DISTRIBUTION FOR USE IN ELECTRON TRANSPORT CALCULATIONS. Felder, R. M. (Brookhaven National Lab., Upton, N. Y.). Jul 1969. 65p. Dep. CFSTI.

The formulas required for the calculation of the Mott cross section for scattering of electrons by an unscreened nuclear charge and the Goudsmit-Saunderson angular multiple-scattering distribution for electrons are summarized, and a FORTRAN-IV code which performs these calculations is given. The occurrence of the calculated quantities in electron transport theory is outlined in an introductory section. Subsequent sections contain a detailed summary of the transport model and analytical expressions for the calculated quantities, an outline of the code, a guide to the use of the code, illustrative results, and the code itself. (auth)

28819 (BNL-tr-333) STABILIZING SHELL EFFECTS IN EXCITED NUCLEAR LEVELS AND STRUCTURE PARAMETERS OF THE NEUTRON STRENGTH FUNCTION. Sukhoruchkin, S. I. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yadern. Fiz.; 10: 251-61(1969). 21p. Dep. CFSTI.

This item was previously abstracted from the original language and appeared in NSA as 23: 49445.

28820 (INP-689) OPTICAL MODEL PROGRAMME WITH THE AUTOMATIC SEARCH ROUTINE "ALA-4". Dudek, Alicja (Institute of Nuclear Research, Krakow (Poland)). 1969. 45p. Dep. CFSTI (U. S. Sales Only).

The "ALA-4" programme in GIER-ALGOL IV language for the computation of differential cross sections and polarizations of particles elastically scattered on complex nuclei is presented. The programme permits an automatic search over the space of the nuclear optical model parameters, yielding optimum fit to experimental cross sections. (auth)

28821 (INR-P-1138) MODEL CALCULATIONS OF THE ENERGY AND ANGULAR DISTRIBUTIONS OF LIGHT NUCLEI ACCOMPANYING FISSION. Krogulski, T.; Blocki, J. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 23p. Dep. CFSTI (U. S. Sales Only).

The known energy and angular distributions of light nuclei accompanying fission of heavy nuclei are transformed to the initial conditions of three-body motion treated classically, i.e., in terms of the Coulomb interaction. It is assumed that these initial conditions are closely related to the scissioning configuration of the nucleus. Hence some conclusions concerning the latter and a comparison with the predictions of the liquid drop model are presented. (auth)

28822 (ITF-69-64) LOCAL SELF-CONSISTENT FIELD IN NUCLEI WITH A GREAT NUMBER OF NUCLEONS. Filippov, G. F.; Simenog, I. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 10p. Dep. CFSTI (U. S. Sales Only).

The equations for the local self-consistent field in nuclei with a large number of nucleons are derived. The field is necessary to build the best one-particle wave function for the fermion system. The equations are described as being a simpler approach to the problem than the Hartree-Fock method. (L.W.A.)

28823 (ITF-70-6) THE RIEMANN METHOD IN THE INVERSE PROBLEM OF SCATTERING THEORY. [PART] I. Gugushvili, E. I.; Mentkovskii, Yu. L. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 13p. Dep. CFSTI (U. S. Sales Only).

The main points of the rigorous substantiation of the previously suggested scheme of restoration of the nuclear potential which corresponds to given data of the nuclear-Coulomb scattering are considered. (auth)

28824 (JINR-P4-4966) ROTATIONAL MOTION IN ODD-MASS DEFORMED NUCLEI. Pyatov, N. I.; Chernei, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 39p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The present status of the theory of rotational motion in odd-mass deformed nuclei is reviewed. Cranking-model description of rotational bands based on intrinsic excited states is considered. Special attention is paid to the effects of coupling of intrinsic and rotational motion which have been revealed recently in nuclear reaction studies. Some nonadiabatical methods are discussed and the examples of nonadiabatic calculations are presented. (48 references) (auth)

28825 (KFK-tr-308) STATISTICAL ANALYSIS OF THE SPIN DEPENDENCE OF THE NEUTRON STRENGTH FUNCTION OF THE NUCLEUS. Maletski, Kh.; Pikel'ner, L. B.; Salamatin, I. M.; Sharapov, E. I. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, Ger.), from report JINR-P3-4484. 25p. (in German). Dep. CFSTI (U. S. Sales Only).

The statistical properties of the estimations of the strength functions are derived, and the distribution of the difference of the strength function for two spin states is determined theoretically. The theoretical results are compared with experimental data from the literature. The results showed that the difference in the strength functions does not occur in all nuclei but only in individual mass number areas. Where the strength functions vary strongly with A, the characteristics of the differences are difficult to determine within the framework of the analysis made, especially as there are no theoretical assumptions on the sign and magnitude of the effect to be expected. There is no basis for the assumption of an essential and common dependence of the strength function on the spin. (J.S.R.)

28826 (LYCEN-7015) NUCLEON ELASTIC SCATTERING WITH NON-LOCAL SEPARABLE POTENTIALS. Pigeon, J.; Barguil, J.; Fayard, C.; Lamot, G.-H.; El Baz, E. (Lyon Univ. (France). Institut de Physique Nucleaire). 5 Mar 1970. 9p. Dep. CFSTI (U. S. Sales Only).

The neutron or proton elastic scattering on ^{4}He below 22 MeV was studied using a one-term nonlocal separable potential. The theoretical phase shifts obtained are in very good agreement with the experimental data. The nuclear potential, chosen identical for the neutron and proton, gives nearly identical parameters. (auth) (France)

28827 (ORNL-tr-2267) CASCADE MODEL OF PHOTONUCLEAR REACTIONS. Gudima, K. K.; Iljinov, A. S.; Toneev, V. C. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Oak Ridge National Lab., Tenn., from report JINR-P2-4661. 11p. Dep. CFSTI.

This item was previously abstracted from the original language and appeared in NSA as 24: 5441.

28828 MULTIPARTICLE NUCLEAR REACTIONS. Holmgren, H. D. (Univ. of Maryland, College Park). pp 213-45 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

The processes by which various multiparticle final state nuclear reactions can take place are discussed. Calculations of the kinematic behavior of three and four-body final state reactions are illustrated using the velocity vector diagram method. Experimental procedures employing relatively simple apparatus are considered. Angular correlation and branching ratio measurements are discussed and procedures for obtaining spectroscopic information from such measurements are considered. (auth)

28829 SHELL MODEL CALCULATIONS. Pinkston, W. T. (Vanderbilt Univ., Nashville). pp 419-32 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

A brief summary is given of nuclear shell model techniques and recent applications of these techniques to nuclei in the 1p-shell and in the (2s,1d)-shell. (auth)

28830 THEORETICAL PROBLEMS IN LOW ENERGY REACTIONS. Stephenson, G. J. Jr. (Univ. of Maryland, College Park). pp 433-44 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

Some theoretical problems related to the analysis of the intrinsic shapes of light nuclei which may be studied by low energy reactions are described. The present understanding of the Hartree-Fock method and its derivatives is discussed. (J.W.R.)

28831 ISOBARIC SPIN EFFECTS IN NUCLEAR REACTIONS. Marion, Jerry B. (Univ. of Maryland, College Park). pp 497-515 of Nuclear Research With Low Energy Accelerators. /Marion, Jerry B. (ed.). New York; Academic Press Inc. (1967).

From Symposium on Nuclear Physics Research with Low-Energy Accelerators, College Park, Md. See CONF-670615.

Methods for the determination of the isobaric spin impurity, or T-mixing, of nuclear levels are discussed. Some particular cases for T = 0 and T = 1 mixtures in N = Z nuclei are described. (J.W.R.)

28832 THE CHANGE OF NUCLEAR ORIENTATION PARAMETERS RELATED TO PSEUDO-CONTINUOUS NEUTRON-CAPTURE GAMMA-RAY SPECTRA. Postma, H.; Potters, J. F. M. (Kamerlingh Onnes Laboratorium, Leiden. Reactor Centrum Nederland, Petten). Physica; 45: 559-74(26 Jan 1970).

Calculations of disorientation parameters, $\langle G_1 \rangle$, $\langle G_2 \rangle$, and $\langle G_4 \rangle$, carried out in two different ways for pseudo-continuous neutron-capture gamma-ray spectra are reported. In the first calculations a very simple model in which a constant number of dipole transitions is assumed was used. Second, computer calculations were done with a more realistic model for level densities and transition probabilities. In the latter case also gamma multiplicities were calculated. A comparison with experimental data is made. (auth)

28833 COMPARISON BETWEEN RELATIVISTIC AND NON-RELATIVISTIC FORM FACTORS IN THE OSCILLATOR MODEL. Cocho, G.; Flores, J. (Univ., Mexico, Mexico City). Nucl. Phys.; A143: 529-36(1970).

Using wave functions classified by the irreducible representations of the non-compact group U(3,1), relativistic form factors are defined and an explicit formula for them is obtained in the case of the completely symmetric representation. A comparison between these form factors and their non-relativistic limit — those extracted from three-dimensional harmonic oscillator wave functions — is given. It is shown that, even for light systems and rather large momentum transfers, the effect of the relativistic correction does not exceed a few percent. (auth)

28834 SOLUTION OF BOHR'S COLLECTIVE HAMILTONIAN. Dussel, G. G. (Carnegie-Mellon Univ., Pittsburgh); Bes, D. R. Contracts 760(15)-024-439; AT(11-1)-1764. Nucl. Phys.; A143: 623-40(1970).

The Bohr collective Hamiltonian is diagonalized within the basic set of states corresponding to the quadrupole vibrator around the spherical equilibrium position. The dependence of the solution on the properties of the basis is discussed. Typical computer times used in the application of the method are given. The minimum number of spherical phonons that is needed in order to represent transition and well-deformed nuclei is also obtained. (auth)

28835 ONE- AND TWO-PARTICLE EXCITATION WITH GOOD ISOSPIN. Soga, Michitoshi (Western Michigan Univ., Kalamazoo. Franklin Inst., Swarthmore, Pa.). Nucl. Phys.; A143: 652-72(1970).

One-particle excitation operators with good isospin are introduced and classified as isoscalars or isovectors. They are applied to some gamma-ray transitions to determine selection rules. Similarly, two-particle excitation operators with good isospin are introduced and classified as isoscalars, isovectors, or isotensors. They are applied to pairing excitation modes of nuclei with N > Z. (auth)

28836 ROTONS IN DESCRIPTION OF NUCLEAR TRANSITION RATES. Nadjakov, E.; Mikhailov, I. N. (Inst. of Physics, Sofia. Joint Inst. for Nuclear Research, Dubna, USSR). Compt. Rend. Acad. Bulg. Sci.; 22: 1377-80(1969).

Formulas for transition rates between states of one or two rotational bands are discussed in terms of rotons. The roton description of transition rates produces the same results as the unified model does in the limit where this model is supposed to be exact. (L.W.A.)

28837 QUADRUPOLE MOMENTS OF EXCITED STATES IN LIGHT NUCLEI. Castel, B. (Queen's Univ., Kingston, Ont.); Stewart, K. W. C.; Parikh, J. C. Lett. Nuovo Cim.; 3: 23-6(1 Jan 1970).

The SU_3 model and the projected Hartree-Fock (PHF) calculations are shown to predict that the ratio Q_J/Q_O (Q_J represents the intrinsic quadrupole moment of the J state) decreases with energy for ^{28}Si and ^{24}Mg. This implies that the intrinsic quadrupole moment is decreasing as one goes up the rotational band, rather than staying constant as expected in the rotational model. (L.W.A.)

28838 A SHELL MODEL DESCRIPTION OF ISOBARIC ANALOGUE STATES IN ^{20}Ne AND ^{24}Mg. Ananthanarayanan, K. (MATSCIENCE, Madras). pp 20-4 of Nuclear Physics Symposium, Calcutta, July 15-19, 1969. /Baliga, B. B. (ed.). Calcutta; Saha Inst. of Nuclear Physics (1969).

See CONF-690716.

A shell model description of isobaric analog states in ^{20}Ne and ^{24}Mg is discussed. Energy levels for ^{20}Ne, calculated for various two-body potentials, are presented in tabular form. Also pre-

sented in tabular form are the results of the M1 decay for ^{20}Ne which are in good agreement with the Stanford experiment for the M1 decay rate from T = 2, J = 0$^+$ to the ground state and to the calculated log ft value for the Gamow–Teller allowed beta decay from ^{20}O to the T = 1, J = 1$^+$ excited state of ^{20}Ne. (L.W.A.)

28839 THOMAS–FERMI CALCULATIONS IN NUCLEI. Pandaripande, V. R. (Tata Inst. of Fundamental Research, Bombay). pp 25–33 of Nuclear Physics Symposium, Calcutta, July 15–19, 1969. /Baliga, B. B. (ed.). Calcutta; Saha Inst. of Nuclear Physics (1969).
See CONF-690716.

The Thomas–Fermi theory of nuclei, which utilizes the solution of the nuclear matter problem in the treatment of finite nuclei is discussed. A correction for the potential energy per nucleon, the effective interaction approach of Nemeth and Bethe, is presented. The calculation of core-polarization effects and the real part of an optical model potential for neutrons and protons are also discussed. Volume conservation in nuclei is mentioned. (L.W.A.)

28840 SUMMARY OF THE THEORETICAL NUCLEAR PHYSICS WORK AT B. H. U. Mathur, V. S. (Banaras Hindu Univ., India). pp 40–3 of Nuclear Physics Symposium, Calcutta, July 15–19, 1969. /Baliga, B. B. (ed.). Calcutta; Saha Inst. of Nuclear Physics (1969).
See CONF-690716.

A brief description of the experimental program in theoretical nuclear physics is presented. The work with trinucleons and the comparison of ^{3}He to ^{3}H is discussed. (L.W.A.)

28841 ACTIVITIES OF THE NUCLEAR PHYSICS GROUP AT ALIGARH MUSLIM UNIVERSITY. Naqvi, J. H. (Aligarh Muslim Univ., India). pp 44 of Nuclear Physics Symposium, Calcutta, July 15–19, 1969. /Baliga, B. B. (ed.). Calcutta; Saha Inst. of Nuclear Physics (1969).
See CONF-690716.

A brief description of the theoretical program, which consists of work on an optical model and on a two-nucleon potential which is non-local but separable, is presented. (L.W.A.)

28842 SUMMARY OF THE WORK IN PROGRESS IN THE THEORETICAL NUCLEAR PHYSICS GROUP AT I. S. I. Ramachandran, G. (Indian Statistical Inst., Calcutta). pp 45–9 of Nuclear Physics Symposium, Calcutta, July 15–19, 1969. /Baliga, B. B. (ed.). Calcutta; Saha Inst. of Nuclear Physics (1969).
See CONF-690716.

A brief description of research on the questionable existence of a phase difference between the S- and D-states of the deuteron and the impulse approximation theory of elementary particle reactions on nuclear targets is given. (L.W.A.)

28843 SUMMARY OF THE WORK IN PROGRESS IN THE NUCLEAR PHYSICS GROUP AT P. R. L. Pandya, S. P. (Physical Research Lab., Ahmedabad, India). pp 50–2 of Nuclear Physics Symposium, Calcutta, July 15–19, 1969. /Baliga, B. B. (ed.). Calcutta; Saha Inst. of Nuclear Physics (1969).
See CONF-690716.

A brief description of the theoretical program on pion capture in light nuclei and Hartree–Fock calculations is presented. (L.W.A.)

28844 SUMMARY OF THE WORK IN PROGRESS IN THE THEORETICAL PHYSICS GROUP OF TIFR. Banerjee, B. (Tata Inst. of Fundamental Research, Bombay). pp 53–6 of Nuclear Physics Symposium, Calcutta, July 15–19, 1969. /Baliga, B. B. (ed.). Calcutta; Saha Inst. of Nuclear Physics (1969).
See CONF-690716.

A brief description of the work in theoretical physics is presented. The topics discussed are spectroscopic calculations in p, s-d, and p-f shell, projected Hartree–Fock–Bogolyubov calculations, variational calculation of the spectrum of even Cd isotopes, charge form factor of ^{4}He, ^{6}Li(p,pd) reactions, and ^{7}Li(π^-,2n) reactions. (L.W.A.)

28845 REPORT OF THE WORK ON THEORETICAL NUCLEAR PHYSICS AT SINP. Nair, S. C. K. (Saha Inst. of Nuclear Physics, Calcutta). pp 57–60 of Nuclear Physics Symposium, Calcutta, July 15–19, 1969. /Baliga, B. B. (ed.). Calcutta; Saha Inst. of Nuclear Physics (1969).
See CONF-690716.

A brief résumé of the theoretical programs on nuclear structure and nuclear reactions is presented. (L.W.A.)

28846 NUCLEAR REACTIONS. McCarthy, I. E. The Commonwealth and International Library. Selected Readings in Physics. Oxford; Pergamon Press Ltd. (1970). 334p. $5.50.

Nuclear reactions are discussed via the principles of quantum mechanics. Basic areas covered include the compound nucleus, the optical model, nuclear structure and forces, and direct interactions. Twelve original papers are also contained in the book. (L.W.A.)

28847 CALCULATIONS OF P_2, P_4, AND P_6 EQUILIBRIUM DISTORTIONS IN THE RARE-EARTH REGION. Moeller, Peter (Lund Inst. of Tech., Sweden). Nucl. Phys.; A142: 1-11(1970).

Equilibrium distortions of nuclei in the rare-earth region are calculated on the basis of a modified oscillator model. In particular, quadrupole (P_2), hexadecapole (P_4), and hexakontatettarapole (P_6) deformations are considered. The effect, especially on P_4 distortions, of taking into account the coupling of the P_4 term to different numbers of oscillator shells is studied. The equilibrium distortions are also calculated when the average behavior of the energy surface is normalized to that of a liquid drop according to the method developed by Strutinsky. (auth)

28848 NEW APPROACH TO THE THREE-BODY PROBLEM. Gloeckle, W. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Phys.; A141: 620-30(1970).

A set of three integral equations for the wave functions of the three-body problem is proposed. One of these equations is the Lippmann–Schwinger equation, the other two are homogeneous equations and complete the definition of the boundary conditions. The two methods proposed to solve this system reduce to a Hilbert–Schmidt problem in a two-vector space. (auth)

28849 SLATER INTEGRALS FOR THE WAVE FUNCTIONS OF THE HARMONIC OSCILLATOR. Wegner, Franz (Institut Max von Laue–Paul Langevin, Garching, Ger.). Nucl. Phys.; A141: 609-19(1970).

Formulas for calculating Slater integrals of local two-particle interactions for the wave functions of the harmonic oscillator are given. They are derived by means of an addition theorem for Laguerre polynomials connecting the polynomials in the squares of the relative and the single-particle coordinates. Therefore, no transformation of single-particle states to relative and c.m. coördinates is necessary. The number of terms to be evaluated is smaller than in formulas of earlier papers. The formulas can also be applied to anisotropic systems and to systems with particles of different oscillator constants involved. (auth)

28850 GAMMA-RAY DE-EXCITATION OF COMPOUND-NUCLEUS-REACTION PRODUCTS. Newton, J. O.; Stephens, F. S.; Diamond, R. M.; Kelly, W. H.; Ward, D. (Univ. of California, Berkeley). Nucl. Phys.; A141: 631-40(1970).

The data currently available on the gamma-ray de-excitation of compound-nucleus-reaction products are summarized. They are shown to be consistent with the de-excitation process outlined by Grover and co-workers, when this is extended to include admixed collective bands. It appears that the presence or absence of an energy gap at a given angular momentum may play a crucial role in the gamma-ray cascade, thereby providing a source of information on nuclear pairing in states with large angular momentum. (auth)

28851 NOTE ON THE CHARGE FORM FACTOR OF ^{4}He. Radhakant, S.; Khadkikar, S. B.; Banerjee, B. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys.; A142: 81-6 (1970).

It is shown that the charge form factor of ^{4}He can be explained with a simple modification of the usual harmonic oscillator orbitals, and without introducing short-range correlations. The binding energy is also calculated with the modified wave function using the Tabakin interaction. It is found that the binding energy and the form factor are sensitive to the off-diagonal matrix elements of the interaction. (auth)

28852 BOSON EXPANSIONS FOR AN EXACTLY SOLUBLE MODEL OF INTERACTING FERMIONS WITH SU(3) SYMMETRY. Li, Shou Yung; Klein, Abraham; Dreizler, R. M. (Univ. of Pennsylvania, Philadelphia). J. Math. Phys. (N. Y.); 11: 975-85(Mar 1970).

An exactly soluble three-level model for a system of fermions with Hamiltonian formed from generators of the group SU(3) is studied. A basis for the representation of which the ground state is a member is constructed. It is demonstrated that in this representation, the generators can each be expanded in a series as functions of a pair of "kinematical" boson operators; the series are uniquely determined to satisfy the operator algebra and the invariants of the representation by a method of Marumori. It is seen that the lowest anharmonic approximation to the Hamiltonian and other operators yields excellent numerical agreement with

exact results for all regimes of interaction strength considered. An alternative description of the system in terms of a dynamically more meaningful boson, called the "physical" boson, is shown to be appropriate for relatively weak coupling where one has a near harmonic spectrum. (auth)

28853 O(5) BASES FOR NUCLEAR SENIORITY MODEL. Ahmed, K.; Sharp, R. T. (McGill Univ., Montreal). J. Math. Phys. (N. Y.); 11: 1113-17(Mar 1970).

Two complete sets of bases are given for the general representation of O(5), utilizing the SU(2) subgroup which classifies nuclear seniority model states. The first set, which is analogous to the SU(3) ⊃ O(3) states of Elliott and Harvey, is formed by projecting good SU(2) states out of certain "intrinsic" states. The second set is analogous to the SU(3) ⊃ O(3) states defined by Moshinsky and Bargmann; each state is characterized by a particular simple term which appears in the expansion of that state and no other. Transformation matrices between the two sets of states are given. The utility of the states for the calculation of generator matrix elements and Clebsch-Gordan coefficients is discussed. The seniority model states of Hecht and Parikh are discussed briefly. (auth)

28854 STUDY OF FEW-NUCLEON SYSTEMS USING RESONATING-GROUP METHOD. Thompson, Donald Robert Jr. Minneapolis; Univ. of Minneapolis (1968). 188p.

Thesis.

The resonating-group method with a one-channel approximation was used to study the bound state and scattering properties of various few-nucleon systems. The major advantages of this method are that a two-body potential between the individual nucleons is employed and that a totally antisymmetric wave function is utilized. Particular attention was given to the mass-six isobaric triad ^{6}He, ^{6}Li, and ^{6}Be, and both three-three (^{3}H + ^{3}H, ^{3}He + ^{3}H, ^{3}He + ^{3}He) and four-two (^{4}He + 2-nucleon) cluster configurations were examined. With scattering boundary conditions, phase shifts and differential elastic scattering cross sections were calculated for these systems. In general, the results were in good agreement with the experimental data. When bound state boundary conditions were employed, the calculation yields a number of levels which lie close to those observed experimentally in these nuclei. The ^{4}He + ^{4}He system was also examined in order to determine effective ^{4}He + ^{4}He local potentials. The results show that these potentials are angular-momentum dependent and are similar to those determined by phenomenological means. (Disser. Abstr.)

28855 MANY-BODY ASPECTS OF LOW-ENERGY NUCLEAR SCATTERING. Brenig, W. (Max-Planck-Institut fuer Physik, Munich). pp 315-38 of Scattering Theory. /Barut, A. O. (ed.). New York; Gordon and Breach Science Publishers Inc. (1969).

The methods for describing the narrow compound-like structure observed in cross sections for low-energy nuclear scattering are discussed. The use of the shell model and perturbation theory are examined in detail. Some model calculations are compared with experimental data. (J.W.R.)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 29068–29073.

28856 (DOCKET-1155-35) LA CROSSE BOILING WATER REACTOR. Provisional Operating Authorization No. DPRA-6. Technical Specifications Change No. 1. (Division of Reactor Licensing (AEC), Washington, D. C.). 11 May 1970. 6p. Dep. CFSTI.

For Dairyland Power Cooperative, La Crosse, Wis.

Cooling system forced circulation flow rate requirements for reactor operation are revised. (D.C.C.)

28857 (GA-10065) OBJECTIVES AND PLANS FOR FUEL TESTING IN THE PEACH BOTTOM HTGR. Steward, K. P. (Gulf General Atomic, Inc., San Diego, Calif.). Apr 23, 1970. Contracts AT(04-3)-633; AT(04-3)-167. 40p. (CONF-700401-3). Dep. CFSTI.

From Gas-Cooled Reactor Program Information Meeting, Oak Ridge, Tenn.

The Peach Bottom reactor offers unique capabilities as a test facility for HTGR fuels. It can irradiate HTGR fuel in a proper neutron spectrum, in a pressurized helium environment, and in an HTGR temperature regime. In addition, the Peach Bottom reactor can accommodate kilogram quantities of test fuels for long periods, and complete fuel element assemblies can be tested to evaluate the interactions of fuel particles, fuel beds, and graphite structures. One of the fundamental objectives of Peach Bottom Core 2 is to exploit the unique capabilities of this reactor as a test facility for irradiation of HTGR fuel concepts. Four types of test elements for insertion with Core 2 are described. Up to 40 test elements may be irradiated within the core at any one time. The major objectives of each element type are as follows: to evaluate the performance of HTGR fuels over a wide range of operating conditions; to provide irradiated HTGR fuel in sufficient quantities to develop recycle processing technology, and to test recycle particles; to provide large-scale tests of 1100-MW(e) HTGR fuel; and to demonstrate irradiation performance of Fort St. Vrain fuel. (auth)

28858 (IN-1372) EVALUATION AND COMPARISON OF STRUCTURAL DYNAMICS INVESTIGATIONS OF THE CAROLINAS VIRGINIA TUBE REACTOR CONTAINMENT. Schmitt, R. C. (Idaho Nuclear Corp., Idaho Falls). May 1970. Contract AT(10-1)-1230. 15p. Dep. CFSTI.

A comparison of the results of investigations to determine the dynamic structural properties of the Carolinas Virginia Tube Reactor Containment is presented. Two independent experimental techniques, an Ambient Vibration Survey and forced excitation tests, and analytical modeling were used. Decisive agreement was not achieved. However, the differences and their possible explanations are of importance as a measure of the understanding of dynamic analysis for complex structures, particularly as related to potential seismic response, and of the need for additional investigations. (8 references) (auth)

28859 OCONEE NUCLEAR STEAM SUPPLY SYSTEM. Montgomery, D. W. (Babcock and Wilcox, Lynchburg, Va.). Nucl. Eng. Int.; 15: 339-41(Apr 1970).

Each of Oconee's three nuclear steam systems is located in its own reactor building and uses a two-loop PWR coolant system. Each loop contains a straight tube and shell once-through steam generator and two reactor coolant pumps. The pressurizer is attached to one of the loops. Descriptions are given of these components. Unique safety features include the penetration room ventilation systems and the use of on-site hydroelectric plant as an emergency power source. The control rod assembly, in-core instrumentation, and steam turbines are briefly described. Details are presented of the station layout and there is reference to the methods of transport of equipment and materials. (UK)

28860 REVIEW OF EXPERIENCE WITH LIGHT-WATER MODERATED POWER REACTORS. Stern, Theodore (Westinghouse Electric Corp., Pittsburgh). Nucl. Energy; 11: No. 2, 36-42(Mar-Apr 1970).

The problems inherent to water reactor plants are reviewed with regard to core power performance, fuel performance, stability of bulk boiling, turbine operation with dry and saturated steam and maintenance of steam generators. The unforeseen phenomena of pH effect and of flow induced vibrations on thermal shields are discussed. The future potential for water reactors as a continuing power producer for electric utility system is considered. (UK)

28861 WORLD'S REACTORS NO. 50: OCONEE. Nucl. Eng. Int.; 15: 344(Apr 1970).

A large pull out chart is presented which comprises a colored sectional drawing of the station with an inset sketch of the reactor, and a comprehensive listing of technical data. (UK)

28862 INDUSTRIAL ASPECTS OF THE DEVELOPMENT OF SODIUM-COOLED REACTORS. van Kampen, C. F. A. Atoomenergie Haar Toepass.; 12: 69-76(Feb 1970). (In Dutch).

The increasing role of industry during the present phase of the development of fast reactors is reviewed, emphasizing the importance of the cooperation between industry, government, and research centers. This collaboration and the participation of the electric utilities in the design and construction of the 300 MW(e) fast breeder German–Benelux reactor is outlined. On the Dutch side, Neratoom functions as the project leader. The prototype reactor will be built by a consortium of five companies; Germany will contribute 70%, Belgium and the Netherlands about 15% each, and Luxembourg 1% of the cost. Each country will fabricate components within its area of competence; the sodium pump, steam generator, and heat exchanger to be built by Neratoom are shown in diagrams. The companies will cooperate commercially in the future on a similar basis. It is expected that more than 100 GW of generating capacity will be installed in Europe before the end of the century. (TTT)

28863 ECONOMIC ASPECTS OF NUCLEAR FUEL FABRICATION AND REPROCESSING IN TURKEY. Dincler, G. (Middle East Technical Univ., Ankara); Kocakusak, O.; Bobleter, O. pp 271-85 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The present and estimated population, annual growth-rate of population, comparison of hydro-, thermal and nuclear power costs and available capacities in Turkey for the future up to the year 2000 are given. The energy resources, their reserves and uses are also discussed, including the large reserves of low-energy lignite recently found near Elbistan in eastern Turkey. Fuel manufacture for various reactor types, their comparison and pertinent questions of reprocessing fuel elements are discussed under the consideration of local conditions. The capacity of Turkish uranium reserves and their economics are briefly mentioned. The present and planned need for energy in 1961-1982, especially by chemical industries, are given in diagrams. The problems of transporting uranium ores to fuel manufacturing plants and transporting used fuel to a planned reprocessing factory are examined and an appropriate solution is offered in the form of a schematic map showing the assumed location of nuclear energy plants, fuel manufacture, reprocessing plants and energy lines throughout the country. The capacity of the reprocessing plant is evaluated on the basis of plans for the increase of nuclear energy production. (auth)

28864 EXPERIENCE OF REFUELLING GAS-COOLED REACTORS. Lawson, D. S.; McPhie, J. (English Electric Reactor Equipment Div., Whetstone, Eng.). pp 3-14 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The experience within one UK organization of refueling gas reactors is reviewed. The design, development, and operational experiences on Mark I (Magnox) gas reactors and the design manufacture work on Mark 2 (AGR) reactors are described. The design and development of loading machines for Mark 3 (HTR) reactors are reviewed. 5 references. (auth)

28865 BRIEF DESCRIPTION OF THE PURPOSE AND OPERATION OF LOADING AND UNLOADING MACHINES AT THE FIRST CZECHOSLOVAK NUCLEAR POWER STATION A-1. Lerach, J.; Pohorelecky, A. (Skoda Works, Pilsen, Czech.). pp 23-34 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970). (In Russian).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The loading and unloading machine is a device for refueling a

reactor operating at full capacity. Apart from operation in the reactor the machine can be used with stationary transfer devices. Operations in the various devices proceed automatically according to a given sequence. The machine consists of a bridge on which a manipulator is mounted, the latter consisting of the following sub-assemblies: hoist, magazine with drive, pressure vessel, head, cooling circuit, water system, gas system and manipulator shielding. The main design parameters: accuracy of approach to a point is ±0.5 mm; the operating pressure is 2.5 to 66 kgf/cm^2; and the cooling capacity ranges from 4.8 to 29 kcal/sec. Tests were carried out on a traveling mechanism, a hoist, a head, a magazine, a cooling circuit, a gas system, flanged connections and electrical equipment. (auth)

28866 MAIN FAILURES IN THE PRIMARY CIRCUIT LEADING TO PLANT POWER LOSS AT THE TOKAI POWER STATION. Imai, Y. (Japan Atomic Power Co. Ltd., Tokai). pp 37-52 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The Tokai Power Station has been generating electric power for nearly three and a half years since its first synchronization in November 1965. We have experienced much serious trouble leading to total loss of power but most of this has concentrated in the primary circuit. The behavior of cooling system failed components and the effect on the availability factor, causes of these failures, countermeasures taken to prevent recurrence of the same faults and the difficulty of repair work are described. The faults in question are fatigue failure of tubes at the low-pressure superheater-tube banks due to Karmann's-Vortex shedding, fracture of splitter plates and fixing bolts at the main gas duct bends, fatigue failure of the internal sleeves of bellows units at the inlet part of the gas circulators and break-away of insulation cover plates at the nozzles of hot-gas outlet ducts. These failures are a common phenomenon on all the four gas circuits and are a matter of design. The causes of these are common and have something to do with vibration or turbulence of dynamic gas flow. Phenomena of this kind are in many cases difficult to forsee by theoretical calculation only. Therefore it is imperative for designers to give consideration to obtaining extended experimental evidence and in choosing the safety factor when they are dealing with such large amounts of mass flow. (auth)

28867 OPERATIONAL BEHAVIOR OF STRUCTURAL COMPONENTS OF THE EL4 PRIMARY CIRCUIT. Martinot, G. (CEA, Paris); Haessig, J. M.; Nguyen Trong, H.; Maille, M. pp 53-87 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

A brief description is presented of the structural components of the EL4 primary circuit: inside the tank (force tubes, thermal insulation); inside the reactor block (channel extensions, tubulars); connections with the heat exchangers and turbo-blowers; and inside the heat exchanger. Details are then given of measurements relating to the behavior of these pieces of equipment (displacement, maintenance of pressure, gas circulation) during cold testing of the reactor and during temperature and power rises. The results of these measurements are presented as a function of the number of blowers used, the number of heat exchangers in operation, the throughput, the temperature and the CO_2 gas pressure for the same operating geometry. A discussion is presented of incidents affecting the behavior of the component parts (turbo-blowers, guide blades in the tubing for recycling of the throughput, concrete temperature, bundles and other heat exchanger parts) and the resulting limitations on the operation of the unit. These limitations are compared with those considered in the project studies. A summary is given of the operating program carried out since criticality. (auth)

28868 SOME PROBLEMS OF THE PRIMARY CIRCUIT PIPING SYSTEM OF THE CZECHOSLOVAK NUCLEAR POWER STATION A-1. Kaisler, L.; Jukl, F.; Milikovsky, J.; Prokopec, M.; Svoboda, M.; Sima, J.; Vokoun, V. (SIGMA Research Inst., Prague). pp 89-103 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The characteristic feature of the KS-150 used for the First Czechoslovak Nuclear Power Station A-1 is the small thermal capacity of the reactor core and consequent quick response of the outlet gas temperature to reactor thermal output. This characteristic produces operational difficulties both in the reactor and the primary circuit piping system, especially in the hot part between reactor and heat exchanger. From this point of view the most serious occasion appears to be a fast reactor shut-down when, after quick breakdown of fission reaction, the heat transferred to the coolant drops very rapidly. These sudden changes in temperature produce extreme local transient strains on the primary circuit parts and make a solution of problems of material properties, dimensioning of primary circuit elements and the achievement of the required service life more difficult. Therefore, more attention was paid to the determination of the thermodynamic character of a flowing medium for stationary and non-stationary work stages, stationary and non-stationary piping system temperature fields and other problems associated with the operation of the piping system discussed, namely, vibration of piping loops as a result of changes in the aerodynamic conditions (e.g., blower shut-down) and to research into pulsation during stable running of the blower. Results of these studies were also used as a base in determining the dimensions of the piping system. The stressing of individual elements has been particularly studied by theoretical and experimental methods. A theoretical solution for the stress in the penetrating shells of T-junctions has been found. The result in trigonometrical series form was verified by measuring both on actual parts and on models. From extensive stress model research, using both photo-elastometric and strain-gauge techniques, a large number of stress data are available. Good agreement has been found between the results achieved by the methods used. To achieve the material properties and service life of the piping system required research into the short and long-term mechanical properties of materials, including low-cycle and high-cycle fatigue. As basic material CSN 415123, heat-treated to produce a Bainitic structure, has been used. This is similar to BS ½Cr½Mo¼V. 4 references. (auth)

28869 TURBO-BLOWERS OF THE SAINT-LAURENT-DES-EAUX NUCLEAR POWER STATION: DESIGN, TESTS, START-UP, AVAILABILITY. Langlade, C. (Compagnie de Construction Mecanique Procedes Sulzer, Paris); Hillairet, J. pp 105-21 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

After recalling the essentials underlying the integrated layout of the Saint-Laurent-des-Eaux power station and emphasizing the very high reliability needed, the functions of the different elements of the blower sets are described. A brief description of the blowers then shows how these essentials were met. The theoretical investigations, as well as laboratory and model tests, are reviewed. A test bench on the site in fact simulated the actual operating conditions and enabled a complete blower set to be tested. 3 references. (auth)

28870 PERFORMANCE OF GLANDLESS PUMPS IN NUCLEAR POWER REACTORS. Worster, R. C.; Ivanoff, V. (Hayward Tyler and Co. Ltd., Luton, Eng.). pp 123-39 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

Operational experience gained with glandless circulating pumps used on the primary circuits of two power reactors is reviewed. Motors of both the wet stator and canned dry stator design are considered and the design and construction of the units are described briefly. Users' operational records on these pumps are examined and analyzed with special regard to outages, leakage rates and convenience of operation. Maintenance schemes are referred to with details of decontamination procedures and typical levels of activity, dismantling, examination and replacement procedures. The average lives of working surfaces such as bearings and impeller wear rings are given, together with the necessary spares required for maintenance. Information is given on special aspects which may be important in nuclear reactors, such as windmilling and reverse flow characteristics when a motor is switched off and the pump runs as a turbine, control of the diffusion of radioactive matter from the pump into the motor cavity by means of clean water purge and the equipment needed to monitor the operation of these pumps. 3 references. (auth)

28871 CANDU OPERATING EXPERIENCE WITH A DELAYED NEUTRON FAILED FUEL LOCATION SYSTEM. Kee, F. J. (Atomic Energy of Canada Ltd., Sheridan Park, Ont.);

Lipsett, J. J. pp 167-83 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

A brief description is given of the principles underlying the design of a failed-fuel location system based on the detection of fission-product delayed neutrons. The design of the system installed in the Douglas Point CANDU Reactor is described in some detail. A summary of the commissioning and of early operating experience is given together with problems encountered and the measures employed to overcome them. Evidence of failed fuel in the reactor appeared while the delayed neutron monitoring system was not available. On its return to service, the first utilization of the system was to search the reactor for these failures. A description is given of the evidence for the onset of fuel failures and of the procedures employed to locate the channels containing failed fuel and in later instances to identify individual faulty bundles through movement of fuel utilizing the fueling machines. Signal levels encountered were considerably greater than predicted but flexibility of the design allowed procedures to be employed which differed from those originally intended. Predicted and actual signal levels are compared and the implications of these signal levels are examined to attempt an assessment of fuel behavior during a critical period between 28 February and 9 March 1969. 10 references. (auth)

28872 FLOW CONTROL COMMISSIONING AND OPERATING EXPERIENCE AT THE LINGEN NUCLEAR POWER PLANT. Reinhardt, A.; Stephan, W. (AEG-Telefunken, Frankfurt am Main). pp 199-214 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

Circulation flow control is a new very effective feature in controlling the power of a nuclear reactor. This kind of control is possible because of the self-control by the physical behavior of boiling-water reactors (BWR). Due to the delay time of the steam bubbles in the core and therefore due to the velocity of core flow, a certain amount of negative reactivity is in the voids. The reactor power will follow the coolant flow. This is a very quick and simple and safe possibility of power control. The Lingen power station (KWL) is the first plant in the world for which flow control by pump speed variation was designed and built. The pumps are controlled by a motor-generator set with a fluid coupling. The speed range is 1:4.3. During start-up it was shown that this device has very good stability and availability. The flow control has a range of 60% of full reactor power. The load rate reached 50%/min. The delay in power changing will be reduced effectively by derivative action of neutron flux. Flow control changes reactor power without changing power shape. Therefore flow control will cause no hot spots. Originally flow control was designed in addition to the well-known rod control. Experience at the Lingen power plant has proved that the former is the most important control feature for BWRs. With this knowledge there is a good possibility for exact design of new BWR control so that load rates of at least 1%/sec are realistic. 10 references. (auth)

28873 DEVELOPMENT AND TESTING THE CONTROL ROD AND ITS DRIVE MECHANISM FOR THE FIRST CZECHOSLOVAK NUCLEAR POWER STATION A-1. Andrlik, V.; Caboun, F.; Drab, F; Havel, J.; Wagner, K. (Skoda Works, Pilsen, Czech.). pp 273-83 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970). (In Russian).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The A-1 heavy-water reactor has 40 control rods. The control rod is tubular in form with a Cd-absorber which is enclosed in hermetically welded Al-alloy sheathing. Each control rod can be moved individually by its own drive mechanism. All mechanisms and rods are thoroughly tested to control specifications. Every control rod and drive mechanism produced undergoes cold and hot tests at operating conditions with 100% cooling gas throughout at 115 to 120°C and 65 kgf/cm^2. Engineering life tests are carried out for prototypes and to test modifications or new components. (auth)

28874 DEVELOPMENTAL, START-UP, AND OPERATING EXPERIENCE WITH BWR CONTROL RODS AND THE CONTROL-ROD SYSTEM OF THE LINGEN NUCLEAR POWER STATION. Plitz, H.; Molitor, F.; Fricke, W.; Voigt, O. (AEG-Telefunken, Frankfurt am Main). pp 285-98 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

When AEG started BWR development for power stations, among the possible control-rod concepts, the boron-SS plate and the boron carbide tube concept, combined with a newly developed control-rod drive system, were chosen. Both a boron-SS-plate and two B_4C-tube prototype control rods were designed and manufactured. These were tested and scrammed in a special facility, simulating BWR scram conditions. The prototypes survived more than 1000 fast scrams without signs of deterioration. After revising the design of the B_4C control rod, the control rods for Lingen Nuclear Power Station (KWL) were manufactured in the new AEG-factory KRT and scram-tested before loading. Their operating behavior after two years of operation is reviewed and compared to Kahl and Gundremmingen Nuclear Power Station experience. No control blade failure was experienced so far, thus backing the reliability of boron carbide control rods. The Lingen reactor is equipped with the newly developed control-rod system consisting of 69 control rods with individual drives. For normal control operation these rods are moved by mechanical means using a screw-nut device. For fast shut-down operation a hydraulic system is provided, employing a hollow piston driven by water which is pressurized by a nitrogen cushion. The design work of the system was supported by extensive testing of full-scale prototypes under hot and cold conditions. During all phases of KWL operation the surveillance system proved to give detailed account of the system operation. With a few exceptions it showed excellent agreement between prototype test results and actual in-plant performance. For these exceptions the sources could be traced and were removed. (auth)

28875 OPERATING EXPERIENCE WITH THE DRAGON STEAM GENERATORS. Holzner, J. (Waagner-Biro AG, Vienna); Gilli, P. V.; Gray, P. S.; McIver, R. F.; Green, I. S. pp 301-19 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

Sufficient experience has been accumulated with the Dragon steam generators to justify the basic design concept chosen, i.e., concentric multi-start helical tube coils in cross flow. The salient features of the mechanical design—heat transfer matrix, tube support, internal sliding gas circuit seals, removable units, large flange seals rendered gas-tight by means of silver gaskets, etc.—have proved their viability very convincingly. Overall gas-side heat transfer and pressure drop behavior is in close agreement with predictions. Water-side data showed a significantly higher two-phase pressure drop than theoretically predicted but within acceptable operating margins. Studies of helium velocity distribution at the inlet revealed the presence of localized helium jets which were suppressed by a gas baffle. Parallel flow dynamic instability (flow pulsations) in the original heat exchangers has been reduced to acceptable amplitudes by tube orifices. After successful operation of the reactor at full load for 200 days tube failures occurred due to corrosion. The corrosion has been shown to be due to failure of the volatile base morpholine to control pH in the presence of traces of acid contaminants in areas where intense local bubble generation or transient local film boiling was occurring. The use of LiOH instead of morpholine and the amelioration of local heat transfer conditions and flow pulsation has led to a satisfactory non-corroding regime. Due to the small core size, high neutron leakage and absence of in-core control rod positions in the Dragon Reactor Experiment a soluble neutron poison (1.5% solution of lithium-6 sulfate) was employed in the secondary coolant to prevent a reactivity excursion in the event of water entering the core. The presence of this neutron poison (which would not be necessary in a large power reactor) made the detection of trace chemical contaminants in the coolant difficult, but did not otherwise appear to affect the corrosion behavior significantly. Tube plugging methods have been developed which gave satisfactory leak tightness in Dragon and might be developed further for the steam generators of large HTRs. Such steam generators can be designed with many basic similarities to the steam generators described. Thus, the experience gained with and the work put into design and operation of the Dragon steam generators are relevant to the design of highly rated steam generators for large nuclear power stations with gas-cooled reactors. 26 references. (auth)

28876 SECTIONAL STEAM GENERATORS FOR THE CZECHOSLOVAK NUCLEAR POWER PLANT A-1. Krizek, V.

(First Brno Engineering Works). pp 321-6 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The first Czechoslovak nuclear power station employs natural uranium fuel, heavy water as moderator and carbon dioxide as heat-transfer medium. The carbon dioxide leaves the reactor at 57 kp/cm^2 and 425°C for the double-pressure primary steam circuit of the generator. A sectional steam generator was designed to permit batch production of the sections, to facilitate their transport and assembly, to simplify the thermal expansion problems and to allow easy removal of each section separately for repair or replacement. Before the sections were put into full production a complete unit was tried out in pilot-plant operation. The nuclear station was a total of six steam generators, each pair feeding one 50-MW turboset. Each generator comprises three parallel units, encased in tight thermally insulated sheet-metal housings and provided with dosimetric extraction points. Every unit consists of two parallel branches of 13 U-sections each. Each of these U-sections, sheathed in a 159-mm diam. tubular jacket, contains 19 22-mm tubes. The tubes carry water or steam, while their outer surfaces are swept by a countercurrent of hot dioxide. The U-bends allow free thermal expansion both of the individual tubes and of the section as a whole. The range of detail design and production problems that had to be overcome in the development of these units is illustrated. A crucial operation in the manufacture of the generator sections is threading the jacket over the bundle of tubes. (auth)

28877 DEVELOPMENT OF NUCLEAR STEAM RAISING EQUIPMENT. Hryniszak, W.; Stead, R. (Clarke Chapman and Co. Ltd., Durham, Eng.). pp 327-46 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The history of nuclear power generation with reference to specific plant designed in the UK and, based upon this history, the future trends for steam raising units are reviewed. Particular note is made of the striking similarity in the problems which have been dealt with in the development of the steam raising units and the reactor for gas-cooled systems. The principal step advances in the nuclear design, namely the fuel and core concept, have been reflected in the gas conditions and hence in the specification for the steam raising units. In addition, there has been an advance from assisted circulation to forced circulation systems, which is closely linked to the change from steel pressure vessels to concrete pressure vessels. Running through all improvements is the search for better economy, which in the context of steam raising units for gas cooled reactors generally means greater compactness. 16 references. (auth)

28878 PERFORMANCE OF PRESTRESSED CONCRETE REACTOR VESSELS OF THE FRENCH NUCLEAR REACTOR PROGRAM FROM MARCOULE TO BUGEY I. Launay, P. A. (CITRA, Paris). pp 363-77 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

Prestressed concrete was used for the first time in France in 1956 to construct the containment vessels for the natural uranium, carbon dioxide-cooled reactors at Marcoule. Since then this technique has been considerably developed, and there are no less than 15 reactors of various types throughout the world which have been or are being constructed with vessels of prestressed concrete. The characteristics of the vessels of the French program are reviewed. Considerations which have to be taken into account in designing a reactor vessel of prestressed concrete and those features of the models which are of particular interest are reviewed. The characteristics required of the various materials and components of the containment are analyzed: the concrete and prestressing cables; the air-tight steel shell; and the thermal insulation and the cooling system. (auth)

28879 DESIGN AND CONSTRUCTION OF THE SIZEWELL REACTOR PRESSURE VESSEL. Poynor, J. F. (Babcock and Wilcox Ltd., London). pp 379-89 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The design, manufacture and inspection techniques applied during the construction of a nuclear pressure vessel are reviewed. These techniques ensure satisfactory performance of the vessel during its service life. A gas-cooled reactor for a 580-MW station that is typical of the steel reactors used in the UK for power generation is considered. The design of the reactor is considered in detail, covering the vessel shell, skirt support and charge nozzle area. The experimental work carried out to optimize the thermal gradients in the skirt/vessel junction is described. Both shop and site fabrication was involved and the general methods used are outlined with emphasis given to welding techniques and non-destructive testing. The site stress relief of the complete vessel was a major undertaking and the control of the complex testing system is illustrated. Finally, the vessel was subject to a pneumatic pressure test involving strain-gauge coverage of the more complex portions of the vessel. Salient features of the test are described together with the inspection carried out after maximum pressure had been reached. 4 references. (auth)

28880 EXPERIENCE FROM THE MANUFACTURE AND TESTING OF THE PRESSURE VESSEL FOR THE A-1 REACTOR. Brumovsky, M.; Becka, J.; Urban, A. (Skoda Works, Pilsen, Czech.). pp 405-32 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The main technical requirements, the technological concept and experimental work conditioning the safety of first Czechoslovak nuclear reactor pressure vessel are presented. Recommendations for pressure vessel operation are presented on the basis of previous work. 13 references. (auth)

28881 STEADY-STATE, TRANSIENT, AND START-UP PROPERTIES OF THE AVR EXPERIMENTAL POWER STATION. Schleifenheimer, K. (Brown Boveri/Krupp Reaktorbau GmbH, Duesseldorf). pp 595-605 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

Much experience and knowledge concerning the behavior characteristics of the helium-cooled high temperature AVR pebble bed reactor at Jülich has been gained since this plant was first brought to power in mid-December 1967. The behavior of the reactor system during both steady-state and transient operation is governed mainly by its strongly negative temperature coefficient of reactivity and the relatively high heat capacity of the core. Because of these properties; the AVR reactor exhibits an extraordinarily stable steady-state operating behavior with built-in self-regulation. This inherent safety also protects the plant against dangerous power and temperature excursions arising from loss of cooling incidents without requiring shutdown of the plant by the automatic safety system. The loss of feed-water supply to the steam generator, on the other hand, requires action by the automatic safety system to protect the steam generator against possible damage. Experiments demonstrated the sufficiency of the designed preventive measures in case of such an incident. Restrictions on the permissible operation of the AVR reactor are imposed by conditions which must be met for the once-through forced flow steam generator and by some material limitations. To ensure flow stability without water pulsations in the steam generator, a feed water flow of at least 25 t/h must be maintained and a gas temperature of at least 600°C must be reached before steam generation begins. The carbon brick bridge, located between the core and the steam generator is subject to thermal stresses arising from temperature gradients. To avoid excessive thermal stresses in this component, the operator must not exceed the permissible heating or cooling rate during routine start-up or shut-down operations. A detailed account of the start-up procedure for the AVR reactor which satisfies the various restrictions is presented. (auth)

28882 ADVANCED NUCLEAR PLANT DESIGN. Drakes, D. F. (British Nuclear Design and Construction Ltd., Whetstone, Eng.). Elec. Eng. (Melbourne); 46: 30-1(Jun 1969).

Factory-built boilers inserted in the reactor pressure-vessel wall of the 1,250 MW twin-reactor nuclear power station being constructed at Hartlepool have accelerated the development of A.G.R.-type stations. The design features of the "pod" system are outlined, and the boiler specifications given. (Australia)

28883 CALEFACTION OF A RIVER. Merriman, Daniel. Sci. Amer.; 222: No. 5, 42-52(May 1970).

The results of a long-term study on the effects of industrial warming on a five-mile stretch of the Connecticut River above and below the Haddam Neck site of the Connecticut Yankee Nuclear Power Plant are discussed. The results indicate that industrial warming of the river has had no drastic biological consequences. (H.D.R.)

Operation and Economics

28884 (DOCKET-50016-38) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Operations Report, February 1970. (Power Reactor Development Co., Detroit, Mich.). 11 May 1970. 11p. (PRDC-EF-78). Dep. CFSTI.

28885 (DOCKET-50029-118) YANKEE NUCLEAR POWER STATION. Operation Report No. 112, April 1970. (Yankee Atomic Electric Co., Westboro, Mass.). 20 May 1970. 6p. Dep. CFSTI.

28886 (DOCKET-50171-50) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 49, March 1970. (Philadelphia Electric Co., Pa.). 18 May 1970. 11p. Dep. CFSTI.

28887 (DOCKET-50206-54) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, April 1970. (Southern California Edison Co., Los Angeles). Contract AT(30-1)-3270. 6p. (NYO-3270-37). Dep. CFSTI.

28888 (DOCKET-50213-43) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 70-4, April 1970. (Connecticut Yankee Atomic Power Co., Haddam). 27 May 1970. Contract AT(30-1)-3250. 14p. (NYO-3250-47). Dep. CFSTI.

28889 (STI/PUB-239) NUCLEAR ENERGY COSTS AND ECONOMIC DEVELOPMENT. Proceedings Series. Proceedings of a Symposium Held in Istanbul, 20-24 October 1969. (International Atomic Energy Agency, Vienna (Austria)). Mar 1970. 758p. (In several languages). (CONF-691020). IAEA $20.00.

Included are 50 papers on the present and projected applications and economics of nuclear power, with particular emphasis on the introduction of low-cost power into the developing countries. A separate abstract was prepared for each of 45 papers. Three papers concern (1) fossil fuel costs in Europe, (2) water resources management, and (3) economics of large desalination units for Kuwait. The two remaining papers were previously abstracted for NSA and may be located under CONF-691020 in the Report Number Index. (H.D.R.)

For abstracts of individual papers see: 28863, 28895-28923, 29021, 29022, 29026-29032, and 29068-29073.

28890 (STI/PUB-240) PERFORMANCE OF NUCLEAR POWER REACTOR COMPONENTS. Proceedings Series. Proceedings of a Symposium Held in Prague, 10-14 November 1969. (International Atomic Energy Agency, Vienna (Austria)). Apr 1970. 690p. (In several languages). (CONF-691115). IAEA $19.00.

Information concerning power reactor component performance is presented under the following topics: on-load refueling machines; primary circuits, pumps, and circulators; reactor instrumentation and control systems; steam generators for gas-cooled reactors; pressure vessels and tubes; startup, operating, and maintenance experience with water reactors; startup, operating, and maintenance experience with gas-cooled reactors; and fast breeder reactors. Separate abstracts are included for 34 of the 39 papers presented. Five papers were previously abstracted for NSA and may be located under CONF-691115 in the Report Number Index. (D.C.C.)

For abstracts of individual papers see: 28864-28881, 28924-28932, 28991, 29008-29011, 29023, and 29059.

28891 (TID-25410) GUNDREMMINGEN NUCLEAR POWER PLANT. Monthly Report, March 1970. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 9 Apr 1970. 42p. (In German). Dep. CFSTI.

The plant was run at full load throughout the month. Malfunctions of the feed-water heaters — some of which failed owing to defects in the level gauging systems — were repaired without the load being reduced. Various measures taken ensured that no limit need be placed on stay-time in the reactor building despite some leaks from primary circuit valves. Only a small change in exhaust gas activity was recorded during the month. (auth)

28892 (WCAP-2713(Rev.)) WESTINGHOUSE REACTOR EVALUATION CENTER. REACTOR OPERATOR TRAINING MANUAL. Hanlen, D. F.; Hamilton, G. N.; Taylor, E. G. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems [Div.]). Revised Oct 1967. 346p.

The Training Program is designed to prepare nuclear power plant personnel for their Senior Reactor Operator License examination. The Manual was written for initial use in Phase I of the Training Program and in subsequent Phases to serve as a study guide and reference. Phase I includes training in basic nuclear and reactor theory, specialized technical and practical knowledge required for reactor operations, and actual operating experience with a low-power training reactor. Intended as a study text in the Phase I, six-week lecture series, the manual covers the basic areas of Atomic and Nuclear Physics, Nuclear Engineering and Technology and Nuclear Safety. Appendixes include AEC Regulations, Typical Licensing Examinations, Sample Reactor Operator Calculations and Radiation Monitoring Instruments. (auth)

28893 SPECIFIC FEATURES OF ATOMIC POWER PLANT FROM THE POINT OF VIEW OF POWER SYSTEM PLANNING AND OPERATION. Umezu, Teruhiro; Ode, Kazuya (Central Research Inst. of Electrical Industry, Tokyo). Denryoku Chuo Kenkyusho Gijutsu Kenkyusho Sogo Hokoku; No. 5, 99p(Aug 1969). (In Japanese).

It is presumed that in Japan the rate of nuclear power generation will occupy about 10% of total power resources in 1975 and about 30% in 1985 and the amount of nuclear power generation will surpass that of steam power generation. The differences between performance of nuclear power plant and that of steam power plant are described. The effects of nuclear power plant characteristics on future designs of power systems are analyzed. (auth) (NSA of Japan)

28894 STOCK STANDARDS FOR THE NUCLEAR FUEL RESERVE IN NUCLEAR POWER PLANTS. Steinbock, P. (Technische Univ., Dresden). Kernenergie; 13: 41-5(Feb 1970). (In German)

An economical stochastic decision model is described which enables nuclear fuel reserve stock standards to be determined in order to eliminate random assembly defects in nuclear power plant operation. Starting from defined reliability of supply, an economical comparison of some versions is made by using a special form of Poisson distribution and covering the relevant expenditures for procuring and floating capital obligations, which results in finding reserve stock standard, maximum reserve stock, and supply cycle. Particular features of nuclear power plants can be taken into account. 6 references. (auth)

28895 CRITERIA OTHER THAN COST FACTORS FOR THE SELECTION OF NUCLEAR STATIONS. Gaussens, J. (CEA, Paris). pp 3-15 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

These criteria are either financial (rate of interest, foreign trade) or industrial (possibility of local industries) or else they relate to the necessity of having assured fuel supplies or promoting scientific activities (participation in decision-making concerning the type and operating characteristics of nuclear power stations). The economic importance of these criteria for a given country is defined. Reference is made to the theory of selection in using multiple criteria. Particular examples taken from French experience are cited. A brief description is given of a model decision regarding choices to be made at some unknown future date. This model makes it possible to take decisions on a rational basis, despite the technical or economic uncertainties, affecting both power stations and their economic environment (short- and long-term costs of reactors and their fueling, etc.) (auth)

28896 NUCLEAR POWER AND NATIONAL ECONOMY. Aikin, A. M. (Atomic Energy of Canada Ltd., Ottawa). pp 17-23 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

Throughout the world a continually increasing demand for electric power stimulates extensive investigation into the most economical means of electricity generation. Comprehensive evaluations show that electric power generated in nuclear power stations is usually competitive with that from oil or coal-fired plants when the unit size is 300 MW(e) or greater. As more nuclear power stations are built experience indicates little difference in capital costs for various reactor concepts. All reactor types result in

higher capital costs than those of conventional thermal plants and thus the competitive position of nuclear power stations depends on their low fueling costs. These costs are lowest when natural uranium is burned directly, which also has the advantage of diverse sources of supply and a simple fuel cycle. Reactors utilizing the excellent moderating properties of heavy water are best suited to natural uranium fuels, although use of heavy water results in slight increases in capital and operating costs. Particular circumstances in each individual country must be evaluated in relation to introducing nuclear power. Availability of fuel, foreign exchange requirements, capability of local industry to manufacture nuclear components, cost of money, and plant operational and reliability requirements are often as important as generating costs. (auth)

28897 GROWTH OF DEMAND FOR ENERGY AND THE ROLE OF NUCLEAR POWER. Searby, P. J. (United Kingdom Atomic Energy Authority, London). pp 25-38 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The development of energy resources is a prior and basic requirement for the economic development of a country to the level of industrialization and trading necessary to secure a high standard of living. The balance between the consumption of various energy forms will vary according to the needs of individual countries and will change with time. The fact that a country's political boundaries (on which energy statistics are generally based) do not necessarily also define a single natural economic region must also be borne in mind. Furthermore, investment in the energy sector must bear a proper relation to total investment if scarce resources, particularly of capital, are to be put to their most productive use. Against a review of the trend of world primary energy requirements, the role of energy in a number of countries in widely different stages of development is considered and some of the factors which contribute to their positions and prospects are examined. Helping developing countries to a higher stage of development by increasing the supply of energy, particularly of nuclear power is discussed. It is recognized, however, that the introduction of nuclear power is a complex matter affecting different countries in different ways but, because the size of electricity systems is rising and nuclear power costs are falling, nuclear power is becoming ever more favorably placed to supply the energy needs of developing countries. The main technico-economic characteristics of the various nuclear reactors which the United Kingdom has developed or is developing are examined and the costs of nuclear power generation in the medium and long term considered. Against this background the economic significance of proven and projected nuclear power systems for developing countries is discussed, special reference being made to the need to take account of the wider economic, social (and indeed political) factors which may affect the choices open to individual countries and areas. (auth)

28898 COST EXPERIENCE AND TRENDS IN THE COST OF PRESSURIZED-WATER REACTORS. Wright, J. H. (Westinghouse Electric Corp., Pittsburgh). pp 51-61 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The status of nuclear plant cost experience in the United States of America is frequently described in the current literature as having risen by 50% or more in the past four years. These statements have led many to conclude that the future trends for nuclear power are rather dismal. In this time period, a complete cycle in the pendulum swing has occurred from the overly optimistic estimate made in the mid-1960s to the gloom and doom stories of today. Looking at the actual facts as they appear through the experience of numerous turnkey projects, it becomes increasingly apparent that neither extreme of the pendulum swing properly depicts the present situation or the future trends. The factors affecting the cost of nuclear plants, such as equipment engineering, craft labor, schedule and escalation, are examined in detail and compared with current experience on fossil plants. Wide variations in plant costs can be and are being experienced from one location to another. This location effect is most notable as a result of craft labour rates and productivity. This study reveals that the nuclear plant cost problems, compared to fossil plants, are largely associated with the longer schedule for nuclear plants. The field labor content is actually smaller for a nuclear plant owing to its much higher shop fabrication content. Furthermore, inflationary factors are also applied to nuclear and fossil-fuel costs to show the significance of the total effect. The results of present experiences and trends now being established suggest that the competition between nuclear and fossil power plants will continue to be vigorous in the years ahead. (auth)

28899 EXPERIENCE GAINED IN CONSTRUCTING ARGENTINA'S NUCLEAR POWER STATION. Csik, B. J. (Comision Nacional de Energia Atomica, Buenos Aires). pp 115-23 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970). (In Spanish).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The planning and construction of the Atucha Nuclear Power Station, which is expected to be put into operation in 1972, has been analyzed from the economic and financial point of view. Comments are made on the methods and criteria used and the results obtained in the stages prior to starting the work. Details are given of the installation cost of the station, the contribution made by Argentine industry and the effect on the technological development of the country. (auth)

28900 ESTIMATED CONVENTIONAL AND NUCLEAR POWER GENERATION COSTS IN PAKISTAN. Quaiyum, M. A. (Pakistan Atomic Energy Commission, Karachi). pp 127-40 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The power development in Pakistan and the existing power system are briefly reviewed. The future load forecasts for both East and West Pakistan are also presented and the future planned development of power discussed. Indigenous resources, such as coal, oil, natural gas and hydro potential for meeting long-term requirements are considered. Characteristics and costs of power sources in Pakistan are presented in some detail. In this connection the following plants are considered: steam, diesel, gas turbine, hydro-electric and nuclear plants. Estimated generation costs from both conventional and nuclear plants are calculated, showing separately the system capital costs, as well as annual operation, maintenance and fuel costs. From the estimated cost the competitiveness of nuclear power is examined. The possibility of introducing a dual-purpose nuclear plant in the national system is also examined fully from an economic point of view. A preliminary cost estimate showing the rates of electricity generation and water desalination from such a plant is also made. It is concluded that the generation cost of electricity from conventional sources is comparatively high. This is a considerable hindrance to the national development and is more severe in East Pakistan where the hydro potential is very limited. In view of the scarcity of fossil fuels in Pakistan nuclear power is considered to be a very promising source of cheap electricity for sustaining and accelerating the country's economic development. Further studies on dual-purpose nuclear desalination plants or agro-industrial complexes may be undertaken with a view to establishing their technical and economic feasibility. (auth)

28901 SHORT-TERM PROSPECTS FOR CONVENTIONAL AND NUCLEAR POWER GENERATION COSTS IN TURKEY. Aybers, N. (Technical Univ., Istanbul). pp 141-61 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

Questions are outlined concerning the economic feasibility of medium-size nuclear power plants, which could be readily absorbed into the relatively small electric power grids of a developing country such as Turkey. The present power situation, power and energy forecasts, are reviewed and it is shown that, despite completion of the new hydro and thermal schemes, at present being planned, there will be a marked energy and power deficit beyond 1982. But the situation necessitates a new thermal power plan to meet the temporary energy deficit until the additional large hydro-electric projects on Firat come into operation. Thus, it is anticipated that a nuclear power plant with a capacity of about 300 or 400 MW(e) be operational in 1976 or 1977. It is expected that it would be necessary to introduce a further nuclear power station with a capacity of about 2×600 MW(e) in 1982-1987. For the purpose of comparison, short-term prospects for conventional generation costs are examined. The cost price of energy at the 2×150-MW Seyitomer power plant project, burning lignite, and at the 2×150-MW fuel-oil-fired Ambarli extension project, is estimated. The 350-MW(e) CANDU-PHW nuclear power station is selected as a reference plant in this comparison. The breakdown of the capital cost and all costs incurred in bringing the station up to power are estimated. The influence of local conditions on unit capital cost and on unit energy cost is shown, and the expected cost price of energy for the first

nuclear power station in Turkey is estimated. It is concluded that the unit capital cost and the cost of generation for a medium-size nuclear power plant, because of higher indirect costs, will be somewhat higher than abroad. But, since the cost of thermal power is also rather high, on the basis of this comparison it is anticipated that the power from a 300- or 400-MW(e) nuclear power station would be economically competitive with thermal power supplies in Turkey. To be competitive with large hydro-power installations it would be necessary to have 500- or 600-MW(e) nuclear power stations. 13 references. (auth)

28902 ANALYSIS OF CONDITIONS FOR THE FUTURE INTRODUCTION OF NUCLEAR POWER PLANTS INTO YUGOSLAVIA'S ELECTRIC POWER SYSTEM. Mandic, D.; Mojovic, Lj. (Energoprojekt, Belgrade). pp 175-83 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

A long-term prediction of power consumption and utilization of hydro-power potential, based on the development of the electric power industry in the last decade, and a planned growth for a few coming years, has been set up. An optimization procedure, which is convenient for the analysis of a system with an appreciable participation of hydro plants in power generation, has been applied to determine the conditions of competitive introduction of nuclear plants. The procedure optimizes the hydro-power plant storage management relying on probability analysis. Present worth of costs has been used as the economic criteria throughout the study. For the predicted future cost of lignite and nuclear fuel, the procedure gives the upper limit of investments in nuclear plant relative to the investments in lignite-fired plant, which make the nuclear plant competitive. The load factor for thermal and nuclear plants is indicated. For light- and heavy-water reactor strategies, uranium requirements, plutonium production (or possible breeder introduction based on own plutonium stocks), and capacities in fuel industry that might be justified within the country are examined. (auth)

28903 PROSPECTS AND INDUSTRIAL ASPECTS OF NUCLEAR POWER IN AUSTRIA. Gruemm, H. J. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna). pp 185-9 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The special conditions for the introduction of nuclear power in Austria are discussed. This country disposes of a high hydro-power potential which has been developed only partially up to now. The river running-water stations are carrying the base load supported by thermal plants operating with small load factors. This peculiar structure of the power system leads to some difficulties for the introduction of nuclear power because of the low load factor and large block size compared with the total capacity of the power system. The high capital costs of hydro-power plants nevertheless create good prospects for nuclear power in Austria. Bids for the first plant (ca. 600 MW(e), operation expected in 1975) have been invited for December 1969. Up to now there exist no official plans for the possible development of nuclear power in Austria. To explore the chances of its industrial aspects members of the Austrian Atomforum initiated a detailed study of development models extending to 1990. The main results of this study consisting of prediction bands for nuclear-power capacity, yearly values of equipment and fuel deliveries including the breakdowns of these values for the main production fields are given. An appendix gives guide numbers for power plant and production costs in Austria. (auth)

28904 NUCLEAR POWER AND DESALINATION PROSPECTS IN THE UNITED ARAB REPUBLIC. El-Mofty, O. H. (Atomic Energy Establishment, Cairo). pp 191-6 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The main features of power and water resources in the UAR at present are outlined, and preparations and prospects for the future are given. Power generation has increased to about 4200 MW, of which 2100 MW represent the capacity of the hydro station at the Aswan High Dam. The power transmission system has developed into a national grid of 500 and 132 kW for the south and 220 for Cairo and the delta area. The main source of water, the River Nile, is now fully controlled by the construction of the Aswan High Dam. This makes it possible to carry out large reclamation projects resulting in a considerable increase in the amount of cultivated land and the future full utilization of that part of the Nile waters allocated to Egypt. Preparations for introducing nuclear energy applications were achieved by implementing nuclear training and research and by the decision to introduce nuclear power into the system. A dual-purpose 150-MW power station was chosen as the first nuclear station. In the foreseeable future, nuclear stations will be considered together with thermal stations, since the cheap hydro potential is almost exhausted. The capacity of the system now permits large stations, and a combination with a large desalination plant would give the nuclear stations an extra advantage. A need for desalted water exists to reclaim about three million acres of land along the northern coast; also small desalination units are needed for mining industries and communities along the Red Sea coast and the Sinai Peninsula. By desalting the brackish waters of the irrigation drains, much land in the north delta can be reclaimed. Mention is also made of applications of certain types of nuclear explosions as an example of long-range planning prospects. (auth)

28905 NUCLEAR POWER IN GREECE. EVALUATION PROCEDURE. Darras, D. (Public Power Corp., Athens); Cassapoglou, C.; Andreadis, C.; Margaritidis, P.; Chrysochoides, N. pp 197-214 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The consumption of electric energy in Greece has been doubling every five years since 1950. Electric energy is at present generated by several power stations with an installed capacity of about 2000 MW. Following the results of a feasibility study, specifications were prepared for the installation of a nuclear power unit. The size was set in the 350-500 MW(e) range, in order to allow the suppliers to optimize their proposals. System studies were carried out to investigate the influence of the size of the unit on the stability of the power system. The results show that a plant with two turbo-alternators and a reactor of 450 MW(e), with the possibility of continuing to supply steam to the turbines for a period of 10 to 20 seconds after a minor failure, should be used in order to make full utilization of the plant from the first year of its operation. (auth)

28906 DEVELOPMENT OF ELECTRIC POWER IN ISRAEL: NUCLEAR POWER AND NUCLEAR DESALINATION PROSPECTS. Adar, J. (Israel Atomic Energy Commission, Tel-Aviv). pp 215-24 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The Israel Electric Power System has been growing at a rate of about 12% p.a. during the last decade reaching a peak load of 935 MW(e) in 1968/1969. Energy is generated by relatively large, high-efficiency oil-fired thermal units. System expansion is carried out by groups of similar units—when the first unit of such a group is commissioned, it constitutes up to 20% of the maximum system load. The system load factor is relatively high. The country is very poor in natural energy resources and most of the oil is imported. Israel is already using about 85% of all its natural water resources and for any further economic expansion will have to resort very soon to large-scale desalination. All power stations are interconnected by a country-wide grid and what is less common is the additional integrated national water system which enables a large desalination plant to be base-loaded. All those facts lead to the impending introduction of nuclear power in Israel, either in single or dual-purpose plants. (auth)

28907 ENERGY NEEDS AND PROSPECTS FOR NUCLEAR POWER AND DESALINATION IN INDIA. Thomas, K. T. (Bhabha Atomic Research Centre, Trombay, India). pp 225-35 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The present status of the electric power industry in India is reviewed and the future electricity needs and implementation plans discussed with reference to the exploitable hydro, thermal and nuclear energy resources of the country. Details of the prospects for nuclear power and desalination development are presented. The work at present being carried out in these fields is evaluated. The concept of an agro-industrial complex with nuclear power stations as foci for simultaneous development of the industrial and agricultural sectors of the economy has been presented. (auth)

28908 NUCLEAR ENERGY COSTS IN JAPAN AT PRESENT AND IN THE NEAR FUTURE. Oomachi, S.; Onaga, Y.; Aisaka, K. (Ministry of International Trade and Industry, Tokyo). pp 239-48 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

All efforts are now directed toward nuclear power development in Japan. The economic evaluation of nuclear power is significant because its growth relies heavily on energy costs. With regard to commercial nuclear power stations in Japan, the Tokai Power Plant of Japan Atomic Power Company (GCR, 166 MW(e) is in operation and five other units (LWRs, totaling 2406 MW(e) are now under construction, one of which (322 MW(e)) will become operable in 1969, and two more (800 MW(e)) in 1970. Additional planned units mean that sixteen units with 8600 MW(e) total capacity will be completed by 1975, or 20,000 MW(e) if we include those under construction. By 1985 the total nuclear power generation is estimated to be about 40,000 MW(e). The Tokai Power Plant cannot be considered as an economical unit in the normal sense because of its research and development characteristics as Japan's first commercial-scale nuclear power plant. But most of the present nuclear power plants under construction have estimated costs of 2.30–2.70 Yen/kWh as an average. Although these costs are still somewhat higher than those of oil-fired power stations, it is presumed that the nuclear power costs will soon become thoroughly competitive with them. Because of local interest rates, various restrictions on plant location, and of depreciation methods, the cost of nuclear power in Japan differs considerably from other countries. In addition, an economic evaluation of nuclear power must take account of the future progress in technology, the reduction of construction costs owing to the enlargement of developmental scale and of each unit, and the trend of fuel-cycle costs. Various factors which influence the costs of nuclear power stations in operation or under construction and future problems which will arise in connection with cost estimates of nuclear power are discussed. (auth)

28909 COSTS OF NUCLEAR POWER STATIONS IN ENGLAND AND WALES. Pipe, E. J. (Central Electricity Generating Board, London). pp 249-61 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The CEGB possesses the largest system of interconnected power stations and the greatest capacity of nuclear power plant of any electricity undertaking in the world. They use a very accurate but complex method of assessing the economics of prospective new power stations. A supplementary, and simpler, method is used to review trends of costs and estimates. Nuclear power stations are now costing amounts very close to estimates made at the time of ordering. Nuclear power in the United Kingdom has established a clear economic lead over alternative forms of electricity generation. (auth)

28910 INFLUENCE OF LOCAL CONDITIONS ON THE INSTALLATION OF LOW-POWER NUCLEAR STATIONS. Havard, J. B.; Thiriet, L. (CEA, Paris). pp 263-70 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The numerous factors involved in the decision to have recourse to nuclear power include fuel costs, means of transport, level of industrialization, foreign trade, influence on the economic growth of the country and so on. The threshold above which a nuclear power station can be competitive, taking into account its size and the cost of fossil fuel supplies, is determined. The effects of local conditions on the design of a nuclear power station and its management are examined. Mention is made of the criteria of general interest which should be taken into account in choosing the type of power station and the economic significance of such criteria. (auth)

28911 COST SURVEY OF NUCLEAR POWER STATIONS IN INDUSTRIALIZED AND DEVELOPING COUNTRIES. El-Fouly, M. F. (Atomic Energy Establishment, Cairo). pp 287-304 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

An attempt is made to find a relation between nuclear station size, type and cost. It was the desire to establish a guide to the cost variations of nuclear power stations in nuclear highly industrialized, developing and underdeveloped countries and the degree of their participation. The main aim is to have a primary estimate of the cost for a desired nuclear station that is to be built by a certain country and to help this country face the problems of construction, methods of finance, and to determine the degree of local participation. Stations built between 50 and 1000 MW(e) have been studied. As these stations were built at different time intervals an adjustment of the cost, using the Martenesson method, has been adopted. The percentages of local participation assumed by Galib have been considered to be most fitting. 12 references. (auth)

28912 SELECTION OF OPTIMUM FUEL-LOADING CONDITIONS. Batov, V. V.; Koryakin, Yu. I.; Pushkarev, V. I.; Smirnov, V. G. (Inst. of Atomic Energy, Moscow). pp 339-47 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970). (In Russian).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

A generalized method is considered for calculating the fuel component of electricity generating costs in a large power reactor. The method enables us to calculate these costs for any time interval between successive partial reloadings (the widely used multi-zone reactor), and choose whatever fuel-loading schedule (including first loading) is most economic. The concept of "normalized expenditure" used in the USSR has been taken as the criterion of what is economic. The influence of the various technical and economic parameters on the selection of optimum fuel-loading schedule and conditions has been studied. Results are given of computerized optimization calculations by this method. (auth)

28913 FUTURE TRENDS IN FUEL-CYCLE COSTS FOR MEDIUM-SIZE LIGHT-WATER REACTORS. Hundt, D. (AEG-Telefunken, Frankfurt am Main). pp 349-64 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

An examination of the various phases of the fuel cycle from the economic standpoint and the share of each phase in the total fuel-cycle costs of a 400-MW(e) light-water nuclear power plant of modern design are presented. Reduction of fuel-cycle costs over the last ten years, due to improved core design, is discussed. The influence of cost changes in the various cycle phases on the total fuel-cycle costs is calculated; on this basis it is shown, in the light of the best available forecasts on price trends for uranium concentrate, plutonium, conversion, enrichment, fuel-element fabrication and reprocessing, how the fuel-cycle costs—the factor on which economy of nuclear power plants is based—will be modified in future. The result of this estimate shows that even without considering further improvements in the design of light-water reactors, an increase of uranium prices of about 30% will not result in higher fuel-cycle costs because of cost reductions forecasted for other phases of the cycle because a greater number of units will be made. (auth)

28914 PROSPECTS OF NUCLEAR ENERGY IN COUNTRIES WITH RESTRICTED CAPITAL AND FOREIGN CURRENCY. Boettcher, A.; Kraemer, H.; Wagemann, K. (Kernforschungsalage, Juelich, Ger.). pp 485-99 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

During recent years optimization models have been developed and applied in order to find out the capacity distribution for different power plants which leads to the cheapest power-generating costs in an expanding power grid. In such strategy calculations for rapidly developing countries other optimization criteria may be of additional interest. Besides the minimization of over-all power-generating cost minimum, capital and foreign currency requirements over a long period can be of vital interest. Such calculations have been carried out for a given power grid. Different combinations of such nuclear power plants have been considered that are of interest from these viewpoints. Relationships between savings in capital and foreign currency requirement and the increase in power-generating costs are given and correlated with the necessary capacity of the respective fuel-cycle industry. From the results it can be deduced that HWRs (with natural uranium as well as with Pu-recycle) and HTRs may play a significant role for such countries. (auth)

28915 EVALUATION OF THE GROWTH OF NUCLEAR POWER IN THE FUTURE POWER SYSTEM. Takei, M.; Suzuki, S.; Watanabe, H. (Inst. of Energy Economics, Tokyo). pp 501-19 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The introduction of nuclear power plants into a power system will be determined by the techno-economic conditions within the framework of the whole electric economy. In other words, their future capacities are given through economic competition with

conventional power plants, and the optimum combination of electric power equipment will be attained. The combination of nuclear power reactors is also the result of economic competition between many types of reactors which share the nuclear power in the total system. The techno-economic progress of the nuclear reactors will turn out in favour of an increase in the share for nuclear power. Based on the above-mentioned concepts, a simplified optimization model was developed, using the two specified variables of the load duration curve and the power costs of each electrical equipment. The performance of this model is discussed on the basis of (i) determination of optimum combination of electric power equipment including nuclear power; (ii) simulation analysis of nuclear power capacities from the years 1970 to 2000 with various assumptions for nuclear power costs and fossil-fuel prices; and (iii) effects of future modification of the load duration curve upon nuclear power capacities. (auth)

28916 REDUCTION OF COSTS AS A RESULT OF SERIAL PRODUCTION. Barth, J. (Societe Alsthom, Paris). pp 521-31 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

In order to compete effectively with conventional thermal plants, the builders of nuclear power stations have had to charge, from the very outset, prices lower than the actual cost for the first one in a series, in anticipation of selling a certain number of facilities of the same type. It is interesting to determine the effect of a series produced in appreciably larger numbers than what are regarded as certain to be sold. The breakdown of the total cost of a nuclear power station into its main components is presented. The elasticity of the costs of the different components as a function of the number of facilities of the same type which it is planned to build is reviewed. To what extent the preceding rules are applicable in the very important case where the builder has to work in collaboration with local industry is discussed. (auth)

28917 AN ECONOMIC COMPARISON OF ALTERNATIVE POWER GENERATION STRATEGIES. Maunders, E. J.; Nel, B. M. (South African Atomic Energy Board, Pretoria). pp 533-46 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The introduction of power-generating equipment into a generation network is normally preceded by some form of economic analysis. A method sometimes employed in the past has been the comparison of first-year generation costs of the types of station under consideration. This method suffers from several faults, the most serious being that identical operating conditions are assumed for all types, and this is most certainly not valid especially if the longer-term view is adopted. A technique which is more acceptable is the present-worth technique. This method takes estimated annual expenditures and discounts them back to some datum point. The most obvious disadvantage of this method is that, in order to take the best advantage of its flexibility, different load factors should be assumed for different types of plant, when they are introduced into a generation network: the difficulty lies in determining this load factor. This difficulty is taken care of if the plants under consideration are introduced in turn into a complete generating system, and the total system costs over a number of years are determined on a present-worth basis. With such a method, plants which have the lowest generating costs are allowed the highest load factors, and vice versa, this being determined within the calculation. A computer program was written to perform such a calculation and is described in detail. The model used to demonstrate the program is the South African electricity generating system, and the existing coal-fired stations are incorporated as basic data. The power requirements of the country are then reviewed on a three-monthly basis over a period of thirty years. At each step, if the load growth curve demands it, either a coal-fired station, a thermal converter or a fast-breeder station may be installed. In addition, if a plant is ready for retirement, this, too, may be taken into consideration. At the end of the thirty-year period the total costs of fuel, capital equipment, and costs of associated services are presented, together with an illustration of the way in which station load factors vary with the composition of the generating system. 12 references. (auth)

28918 MODELS FOR ECONOMIC CONSIDERATION ON INTRODUCING NUCLEAR ENERGY. Faude, D.; Jansen, P.; Seetzen, J. (Kernforschungszentrum, Karlsruhe, Ger.). pp 547-65 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The introduction of nuclear energy leads to a reduction in the energy generating costs and, as a consequence, to a direct benefit for the national economy. In this context, the following points are of interest: the importance of the power economy within the framework of the national economy as a whole; the amount of possible cost reduction due to the introduction of nuclear energy and the effectiveness of cost reductions on the various sections of the economy. Nuclear energy will be introduced in two steps: first, the proven reactor types will be installed, especially the light-water-moderated and the heavy-water-moderated thermal converters; these reactor types will be dominant in the 'seventies. However, these proven reactor types are still characterized by a poor nuclear fuel utilization, i.e., in the event of an exclusive use of these reactor types the cheap uranium resources would be exhausted and higher uranium prices would increase the energy generating costs before the end of this century. This problem initiated the development of advanced reactor types, especially the sodium-cooled fast breeders, which will be installed in increasing numbers in the 'eighties and which will be the solution of the long-term energy aspects. When introducing a new reactor concept the development costs and the resulting benefit must be related to each other. Whilst the development costs can be estimated relatively well, the benefit results from the gain in reduced energy generating costs and from the possible introduction rate of the reactor type. The introduction rate depends on the plutonium balance. To carry out this cost-benefit analysis for a given reactor type, the following model is used: a nuclear energy demand curve is estimated; during a first period one proven reactor type will be installed up to the time of installation of the first advanced reactor type; in the following period the advanced reactor type will be installed according to the available plutonium following a two-type strategy. In addition to the cost balances and the mass balances the model makes it possible to determine, for the development costs of this advanced reactor type, either the rate of investment return within a certain period of time or the amortization period for a given interest rate. Taking the Federal Republic of Germany as an example the above-mentioned considerations on power economy are demonstrated and a comparison is made for fast-breeder reactors with different coolants and different fuels and for the high-temperature gas-cooled advanced converter reactors. Because of the uncertainty in cost data, possible ranges are given as results. (auth)

28919 INFLUENCE OF NUCLEAR ENERGY ON THE DEVELOPMENT OF BRAZIL. Lepeckf, W. P. S. (Univ. Federal de Minas Gerais, Belo Horizonte, Brazil). pp 567-81 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The influence of nuclear energy on the technical and economic panorama of a developing country like Brazil is analysed. To put the problem in a correct frame a survey of nuclear energy perspectives in Brazil is made, showing a considerable market for nuclear stations in the next 30 years, giving an average of about one 1000-MW(e) station per year, only for the South Central Region. Based on these forecasts, an estimate is made on the requirements for industry in several areas: mining, fuel-element fabrication, and plant equipment proper. A survey of the impact of this nuclear program on the general level of technological and scientific research and on the economy as a whole is made. It is shown that yearly expenditures in the nuclear program will rise from about 60 million dollars per year in 1975/80 to more than 1000 million per year in 1995/2000. 12 references. (auth)

28920 ROLE OF ELECTRICITY-INTENSIVE INDUSTRIES IN THE ECONOMICS OF NUCLEAR POWER. Mrochek, J. E.; Holmes, J. M.; Michel, J. W. (Oak Ridge National Lab., Tenn.). pp 639-52 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

Nuclear power reactors, with a high proportion of their annual costs contributed by interest charges on capital, are strongly dependent on base load operation for the production of cheap electricity. As the role of nuclear power in national energy production increases, it becomes more difficult to maintain high load factors on individual reactors with the wide variability of hourly and seasonal electricity demands. Electricity-intensive industries located near power-generating centres might be utilized either as variable demand loads or as instant load-shedding devices to smooth out electricity demand and enable efficient utilization of capital-intensive generating facilities. The possible role that electrolytic hydrogen production might play is examined in

detail by comparing the total annual costs of a nuclear power station and electrolytic ammonia plant (enabling the power station to operate at a 90% load factor) with the same power station operating at some lower load factor (which might be typical of utility operation). Both stations produce the same amount of firm power for a hypothetical grid system. For a 1000-MW(e) nuclear power station and a 300-ton/d ammonia plant, a credit of $3/t for oxygen and $48/t for ammonia enables the load-levelized plant to produce power for the same total annual costs (including capital charges at 10% cost of money), as the power plant alone operating at a load factor of 79% (i.e., without a load-levelling industry). The adaptability of other electricity-intensive industrial processes such as chlorine-caustic, aluminum, magnesium metal, arc production of acetylene, electric iron, and elemental phosphorus as load-leveling devices is briefly discussed. A potential near-term application of water electrolysis as a load-leveling device in India is also presented. 20 references. (auth)

28921 ECONOMIC ASPECTS OF NUCLEAR POWER IN TURKEY. Uenal, H. C. (Cekmece Nuclear Research and Training Center, Istanbul). pp 673-96 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

Outlined are Turkey's energy resources; the past, present and future electric power situations; and the large hydro and thermal power plant projects, planned and studied by the State Planning Department to be built possibly during the time covered by the second or the third five-year plan (1967-1972 or 1972-1977). The data are reviewed to obtain a future power balance. Then an economic comparison is made of the power plant projects with the 300-, 400-, 500- and 700-MW(e) BWR and PHWR nuclear power plants on the basis of the unit energy cost. The results indicate that the cost of the nuclear power will be comparable with the cost of the hydro power and cheaper than the cost of the conventional thermal power for the next decade in Turkey. Besides the fact that nuclear power generating will be cheap, the distant location of most of the large hydro potential, and the insufficient coal, lignite and oil resources together urge the necessity of launching a long-range nuclear power development program to generate electricity if the country wants to use its energy resources efficiently. It is anticipated that the first nuclear power station will be generating electricity by 1977 at the latest. 15 references. (auth)

28922 SOME ASPECTS OF POWER SYSTEM EXPANSION IN DEVELOPING COUNTRIES. Goldsmith, K. (Electro-Watt Engineering Services Ltd., Zurich). pp 679-707 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The scale of economic exploitation in developing countries is still below that reached by the industrialized nations but the rate of development often far outpaces them. The rapid growth of the demand for energy which accompanies this development calls for large capital resources and for technical skill well beyond local capabilities. On the other hand, the technical means employed for meeting the demand are equally sophisticated as elsewhere and the same criteria apply for the selection of the optimum technical and economic solutions. Energy in the form of electricity plays a predominant role in a developing economy because it is easy to generate independently of local natural resources—a situation which can favour nuclear plant. Electricity is also easy to transport; the latter is particularly important in areas where the density of communications is low. There is thus a relatively large and fast-growing market for power sources of advanced technology but the market is lacking in financial and technical resources. The factors making up the power market and the generating plant programs needed to supply it are discussed. Particular attention is paid to the demand patterns, the integration of probable large plant units into restricted power systems, cost and financing considerations and questions of staffing and long-term development. Some of the constraints limiting expansion are illustrated. An attempt is made to show what possibilities exist for nuclear plant and what particular characteristics are required of them. The conclusion is reached that the most promising solutions cannot be over-ambitious in the short run and that the feasibility of re-shaping the economy of whole regions by the provision of ample and cheap power is still more than a decade away. (auth)

28923 TRANSMISSION COSTS VERSUS NEAR-LOAD SITING COSTS FOR INLAND REGIONS DEFICIENT IN COOLING WATER. Bowers, H. I.; Wichner, R. P. (Oak Ridge National Lab., Tenn.). pp 709-22 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

A general study was made of the cost of supplying power to an inland city by means of an off-the-coast power plant relative to the cost of power from a near-load facility. It was assumed that cooling water was in short supply near the city, necessitating use of a dry cooling tower for the near-load plant, resulting in higher costs and lower thermal efficiency. In addition, the offshore site had the advantage of requiring lower safeguards costs. On the debit side, the cost of the offshore site would be higher, as would labour costs during construction. The result of the study indicated that the cost of energy at the bus bar would be lower for the offshore plant by 0.1 mill/kWh for a 1000-MW(e) breeder reactor with public financing up to 0.5 mill/kWh for a 10,000 MW(e) light-water reactor with private financing. These savings in the cost of power generation were then applied to the cost of transmitting power to the inland city. It was found that, when comparing plants of equal capacity, transmission distances of from 4 to 80 miles could be accommodated from the savings on generation costs, assuming present-day transmission technology. When it is assumed that large (10,000 MW) offshore plants supply smaller (1000 MW) inland loads, allowable transmission distances ranged from 100 to 480 miles. (auth)

28924 START-UP PROGRAM AT THE ROBERT EMMETT GINNA NUCLEAR POWER PLANT. Powell, E. U. (Westinghouse Electric Corp., Pittsburgh). pp 471-84 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The Robert E. Ginna Power Reactor Unit 1 employs a pressurized water reactor with an initial power rating of 1300 MW(t) and 420 MW net plant electric output. The start-up program covered verification of construction, functional testing of plant systems, fuel loading and the gradual escalation to full power. The organization of start-up personnel is described for the different start-up phases. Some observations are included on the performance of equipment during start-up. (auth)

28925 START-UP AND OPERATING EXPERIENCE WITH THE BOILING-WATER REACTOR OF THE LINGEN NUCLEAR POWER STATION AND ITS COMPONENTS. Schulze, J. (AEG-Telefunken, Frankfurt am Main). pp 485-501 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

Operational experience with the reactor of the Kernkraftwerk Lingen (KWL) now covers a period of 1½ years which allows consideration of the reliability of system functioning and verification of design criteria. The design of the Lingen reactor was based on components already proven in BWR operation. Certain innovations were applied to the design because they promised considerable improvement at a justifiable risk. These risks were diminished by extensive testing of prototypes of the new component under simulated reactor conditions. The most significant innovation is control of the forced circulation flow by means of coolant recirculation pumps with an adjustable speed of revolution. This adds substantially to the ease of plant operation. The control rod drives, one of the newly developed components, caused some trouble during the first heat-up of the reactor due to warping of the trunk pistons. Steam separation is done by an internal steam separator developed by AEG for use in BWRs which showed good performance. The in-core neutron flux instrumentation proved very helpful for optimization of the rod withdrawal sequence. The effects of component performance on availability and operation of the Lingen plant can be seen from the course of start-up testing and subsequent operation. (auth)

28926 LIGHT-WATER REACTOR EXPERIENCE IN THE UNITED STATES OF AMERICA. Wagner, H. A. (Detroit Edison Co.). pp 503-20 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

Problems with early reactors are reviewed. Much has been learned which will be applied to the newer designs to reduce the commissioning and operating problems. Improved quality assurance programs on even the conventional parts are suggested. (auth)

28927 EXPERIENCE WITH THE COMPONENT PERFORMANCE AND PLANT AVAILABILITY ON THE SGHWR POWER PLANT. Smith, D.; Negus, B. (Atomic Energy Establishment, Winfrith, Eng.). pp 521-39 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The SGHWR is a 100-MW(e) direct-cycle nuclear reactor designed and operated by the UKAEA at Winfrith Atomic Energy Establishment. It has been generating electricity for the national grid system since the beginning of 1968. The primary circuit is based on a pressure-tube concept with a light-water coolant. The principal moderation is by heavy water operating at atmospheric pressure. Having demonstrated that the basic concept was fully satisfactory the main purpose of operation has been to demonstrate the choice of components and to obtain information on their reliability. Emphasis has been placed on maximum feedback of operational information to the designer. Operational and maintenance experience has shown that reliable economic performance can be obtained when sufficient regard is paid to the following aspects: component reliability at full power; facilities for on-line repairs and maintenance; redundancy in certain key plant items; access facilities and component simplicity which minimize shut-down time for maintenance; rapid start-up facility; reliability in key shut-down equipment; and adequate pre-operational testing. Detailed examples to illustrate these points are given for the SGHWR experience. Certain areas are apparent where component development could give improved load factors on water-reactor systems. (auth)

28928 TECHNOLOGICAL DIFFICULTIES IN CONSTRUCTION, START-UP, AND OPERATION OF THE NUCLEAR POWER STATIONS OF THE EUROPEAN COMMUNITY. Siebker, M. H. (European Atomic Energy Community, Brussels). pp 541-8 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

One of the reasons for which, up to six months ago, the rate of introduction of nuclear power into the European electricity grids had not reached its target was the existence of serious technological difficulties. Although most of these problems have been solved and the Community has recently observed the placing of six large orders, one kind of action remains essential, quite apart from any other method of promotion or assistance. This is the systematic exchange of the experience acquired in the construction and operation of nuclear power stations. The Commission of the European Communities therefore stipulated from the start in its contracts and directives that experience acquired in projects should be shared, and the Commission itself undertook to transmit this experience to the quarters concerned in the most efficient manner possible. Since 1966 the Commission has been publicizing the experience of all the operators and owners of nuclear power stations in the Community and this has been done without any contractual obligation, purely on a basis of mutual aid and mutual confidence. The experience in question relates to five power stations with boiling-water reactors, four with pressurized water reactors and five with CO_2-graphite reactors, all in operation, one high-temperature gas reactor and two heavy-water reactors, likewise in operation, and half a dozen nuclear power stations under construction. It is generally possible to treat the problems in the context of the technological field to which they belong, independently of individual plants. The short synthesis given therein concerns the following matters: leak-proof containment and associated equipment; reactor vessels and internal parts; fuel elements and associated apparatus; instrumentation and control; control rods and their drives; heat exchangers, pipework, blowers, valves; turbo-alternator sets; treatment of water, gas and effluents. The main conclusions are as follows: the technological difficulties are not such as to compromise the high expectations placed in the advantages of nuclear power; analysis shows that most of the components which caused difficulty are non-nuclear or para-nuclear; it has been shown that a nuclear power station can operate normally even with a number of faulty fuel elements; and certain action is required on the basis of the experience gained by owners and operators, action which concerns producers of electricity, reactor builders and public authorities. (auth)

28929 EXPERIENCE OF THE FIRST SIX MONTHS OF OPERATION OF THE FIRST UNIT OF SAINT-LAURENT-DES-EAUX NUCLEAR POWER STATION. Babinet, G. (Electricite de France, Tours); Teste du Bailler, A. pp 567-82 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The first of the two natural uranium-graphite, gas-cooled reactors at Saint Laurent des Eaux was commissioned on 14 March 1969. Less than four months after the first link-up of the two turbo-alternator sets (2 × 240 MW) with the grid, production reached 500 million kWh. All the facilities of the station have been commissioned and subjected to rigorous tests during continuous and intermittent operation. The behaviour is described of the following equipment: control of the reactor (neutron measurements, control rods, control and regulation); computer (data processing and automatic control); detection of burst cladding; turbo-blowers (auxiliary and main intake); turbo-alternators; fuel handling mechanical devices; and automatic control. (auth)

28930 OPERATING AND MAINTENANCE EXPERIENCE WITH THE AVR EXPERIMENTAL POWER STATION. Bromkamp, K.-H.; Hantke, H.-J. (Brown Boveri/Krupp Reaktorbau GmbH, Duesseldorf). pp 583-94 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The AVR Experimental Power Station is the first power plant to use spherical fuel elements. The reactor core consists of a pebble bed containing roughly 100,000 spheres, each having a diameter of 6 cm. Power production started in September 1967. Up to now 66 million kWh(e) have been produced and a burn-up of 29% mean value has been reached. In spite of the many experiments that had to be carried out in this new type of reactor, the factor of electrical time availability was relatively good, namely 51.4% during 1968, and 92% from October 1968 to March 1969. The main purpose of this experimental power station is to demonstrate the feasibility of this type of high-temperature reactor which has the following advantages: inherent safety and good efficiency because of continuous loading of elements, each representing small amounts of reactivity, so that it is possible to operate the reactor without excess reactivity, with a high burn-up and at steam conditions which are similar to modern coal-fired conventional power plants. The experience gained from the fuel-handling system, the fuel and the various newly developed components is quite satisfactory. During a maintenance and inspection period from 1, 3, 1969 to 15, 4, 1969 various components were inspected and it was found that the radioactive contamination was smaller than expected and that disassembly of the fuel-handling facility could be carried out without shielding. Hence the indications are promising that extrapolation to a 300-MW(e) plant is justified. 3 references. (auth)

28931 MAIN PROBLEMS UNDERLYING A REDUCTION IN THE AVAILABILITY FACTOR. Grangetas, J.; Landais, J. P. (Electricite de France, Paris). pp 607-31 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

Three reactors, Chinon 1, 2 and 3 were built at the Chinon site between 1959 and 1966. These three installations are different both in their power (Chinon 1, 70 MW(e); Chinon 2, 200 MW(e); Chinon 3, 480 MW(e)) and in their construction techniques (steel reactor vessel for Chinon 1 and Chinon 2, concrete vessel for Chinon 3), and represent three developments of the gas-graphite reactor type. Certain difficulties appeared at the start-up of each of these installations. The principal difficulties are discussed. The operation of the following equipment is described: heat exchangers; blower circuits; fuel-handling equipment; electrical generating plant. (auth)

28932 OPERATING EXPERIENCE WITH MAJOR COMPONENTS OF THE ENRICO FERMI ATOMIC POWER PLANT. Duffy, J. G. (Atomic Power Development Associates Inc., Detroit); Wagner, H. A. pp 635-46 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

There is much that can be learned from both the successes and the problems that have been encountered in the design, construction, and operation of the Enrico Fermi plant systems and equipment. The Na heat transport system is a loop (piped) system

which is large enough to be considered generally prototypical of one design of a central station power plant system. The system has proven itself to be durable and, with the exception of the steam generator leakage problem, generally reliable during seven years of operation. Throughout this period of time, the system has been subjected to a large number of startups and shutdowns using both two-loop and three-loop operation over a wide range of flow rates and temperature levels. These conditions included operation of the reactor components test facility portion of the primary system at 1000°F isothermal for seven days. The system has experienced temperature differences as high as 125°F during operation of the reactor at power levels up to 100 MW(th). The successful operation of the Na system over many years has imparted confidence to our operators that, as a heat transfer medium, Na can be handled with a minimum of difficulty. Most of the important equipment has operated very well which leads us to believe that a large size liquid metal cooled reactor system and plant can be designed and built, and further can be operated safely and successfully. (auth)

Safety and Siting

Refer also to abstracts 27234, 27235, 27305, 27312, and 27606.

28933 (BRH/DER-70-2) RADIOACTIVE WASTE DISCHARGES TO THE ENVIRONMENT FROM NUCLEAR POWER FACILITIES. Logsdon, Joe E.; Chissler, Robert I. (Bureau of Radiological Health, Rockville, Md. Div. of Environmental Radiation). Mar 1970. 77p. CFSTI.

Information concerning discharges of radioactive material to the environment by power reactors is presented. Sources of gaseous and liquid waste are described. Operating experiences with radioactive discharges are presented for the following power reactors: Big Rock Point Power Reactor; Connecticut Yankee Power Reactor; Dresden Power Reactor Unit 1; Humboldt Bay Power Reactor; Indian Point Power Reactor Unit 1; Peach Bottom Power Reactor Unit 1; San Onofre Power Reactor Unit 1; Shippingport Pressurized-Water Reactor; and Yankee Power Reactor. 33 references. (D.C.C.)

28934 (CONF-690540–, pp 235-45) RADIOECOLOGICAL STUDIES IN THE EMS BELOW THE LINGEN NUCLEAR POWER PLANT. Feldt, W. (Bundesforschungsanstalt fuer Fischerei, Hamburg (West Germany). Isotopenlaboratorium). (In German).

Release of radioactivity into the Ems River by the Lingen Power Reactor was studied. During the first six months of operation, 1.8 Ci of tritium and 250 m Ci of other radioisotopes were discharged. Gamma spectrometry of the waste water showed significant peaks for ^{141}Ce, ^{51}Cr, ^{58}Co, ^{137}Cs, ^{54}Mn, ^{95}Tc, and ^{60}Co. To study effects on the ecosystem of the river, stable forms of Fe, Mn, Zn, and Cu were released experimentally and the concentrations determined in plants and animals. It was concluded that maximal concentrations should not be established for adult fish but rather for eggs because the latter are more radiosensitive. Mussels at the mouth of the river showed high concentrations of the released samples due to the fact that a mussel bank will clean, within less than ten weeks, a 4m high layer of water by removing all suspended particles. It was concluded that general rules should be established for each river system separately. (H.B.G.)

28935 (CONF-690540–, pp 246-60) CATASTROPIC PROTECTION TRAINING AT THE GUNDREMMINGEN NUCLEAR POWER PLANT: PLANNING, OPERATING SEQUENCE, AND EXPERIENCE. Pohl, W. K. (Bayerisches Staatsministerium des Innern, Munich (West Germany). Oberste Baubehoerde). (In German).

A maximum credible accident was assumed for the Gundremmingen Power Reactor. Countermeasures were based, however, on even more severe damage that might occur under war conditions. Participation in the exercise comprised the plant personnel, the police of surrounding communities, various governmental agencies, several research institutions, but not the population itself. Details of the planning and organization were presented in several diagrams and tables. (H.B.G.)

28936 (CONF-690540–, pp 261-72) CATASTROPHIC PROTECTION TRAINING AT THE GUNDREMMINGEN NUCLEAR POWER PLANT: EXPERIENCE AND THEORY. Kiefer, H. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). (In German).

Radiation protection exercises in connection with the MCA at the Gundremmingen Power Reactor are analyzed. Basic differences between explosion of nuclear weapons and MCA are emphasized. In nuclear weapon explosions, external γ and neutron radiation severely affect countermeasures. In MCA, release of gaseous radioisotopes, especially ^{131}I, represents the dominating factor in evaluating hazards to the population. Problems of rapid ^{131}I measurements are discussed. Blockage of the thyroid by stable iodine, as planned in England, was not considered in Germany. Although numerous technical laboratories and facilities are capable of handling almost any reactor accident, no adequate organization for coordination exists. (H.B.G.)

28937 (DOCKET-1155-36) LA CROSSE BOILING WATER REACTOR. Operator Retraining Program. (Dairyland Power Cooperative, La Crosse, Wis.). 21 May 1970. 5p. Dep. CFSTI.

28938 (DOCKET-50003-39) INDIAN POINT STATION, UNIT NO. 1. Core C Conceptual Design Report. (Consolidated Edison Co. of New York, Inc., New York). Apr 1970. 32p. Dep. CFSTI.

28939 (DOCKET-50003-40) INDIAN POINT STATION, UNIT NO. 1. Dowell Pin Missing. (Consolidated Edison Co. of New York, Inc., New York). 21 May 1970. 4p. Dep. CFSTI.

Efforts to locate and remove a missing piece of dowel pin from a test specimen hold down assembly are described. Effects of the missing piece of dowel pin on safe reactor operations are analyzed. (D.C.C.)

28940 (DOCKET-50016-37) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Request for Extension of Expiration Date of Provisional Operating License. (Power Reactor Development Co., Detroit, Mich.). 27 May 1970. 14p. Dep. CFSTI.

Financial data on the Power Reactor Development Company are presented in support of an extension to the provisional operating license for Fermi Fast Breeder Reactor. (D.C.C.)

28941 (DOCKET-50029-117) YANKEE NUCLEAR POWER STATION. Damage to a Spent Fuel Assembly. (Yankee Atomic Electric Co., Boston, Mass.). 4 Sep 1969. 2p. Dep. CFSTI.

28942 (DOCKET-50133-33) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7: Technical Specifications Change No. 28. Manual Scram Switch. (Division of Reactor Licensing (AEC), Washington, D. C.). 6 May 1970. 2p. Dep. CFSTI.

For Pacific Gas and Electric Co., San Francisco, Calif.

28943 (DOCKET-50146-56) SAXTON REACTOR. Accidental Release of Radioactive Gases. (Saxton Nuclear Experimental Corp., Pa.). 18 May 1970. 2p. Dep. CFSTI.

An accidental release of radioactive gases occurred while venting gases from the primary coolant system to the gas compressor system following a scheduled shutdown of the reactor. The release occurred as a result of rupture of a diaphragm in a gas compressor vacuum regulating valve. Safety procedures following the release are described. (D.C.C.)

28944 (DOCKET-50146-57) SAXTON REACTOR. License No. DPR-4. Technical Specifications Change No. 35. (Division of Reactor Licensing (AEC), Washington, D. C.). 28 May 1970. 2p. Dep. CFSTI.

For Saxton Nuclear Experimental Corp., Pa.

Revised core loading with defected test fuel elements and pressurized creep test fuel rods is presented. (D.C.C.)

28945 (DOCKET-50171-49) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Modification of Bottom Connector for B16.10 Position. (Philadelphia Electric Co., Pa.). 4 May 1970. 5p. Dep. CFSTI.

28946 (DOCKET-50171-51) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. License No. DPR-12: Technical Specifications Change No. 12. (Division of Reactor Licensing (AEC), Washington, D. C.). 28 May 1970. 11p. Dep. CFSTI.

For Philadelphia Electric Co., Pa.

Revised technical specifications are presented on the following systems: containment isolation; reactor core; waste disposal; and test fuel elements. (D.C.C.)

28947 (DOCKET-50213-40) CONNECTICUT YANKEE ATOMIC POWER PLANT. Air Entry into the Waste Gas System. (Connecticut Yankee Atomic Power Co., Westboro, Mass.). 18 May 1970. 3p. Dep. CFSTI.

28948 (DOCKET-50213-41) CONNECTICUT YANKEE ATOMIC POWER PLANT. Control Rod Cluster Assembly Failure. (Connecticut Yankee Atomic Power Co., Haddam). 15 May 1970. 1p. Dep. CFSTI.

28949 (DOCKET-50213-42) CONNECTICUT YANKEE ATOMIC POWER PLANT. Investigation of Furnace Sensitized Safe Ends. (Southwest Research Inst., San Antonio, Tex.). 20 May 1970. 7p. Dep. CFSTI.

For Connecticut Yankee Atomic Power Co., Westboro, Mass.

28950 (DOCKET-50219-73) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Control Rod Drives: Summary of Findings and Conclusions Determined During the Shutdown. (Jersey Central Power and Light Co., Morristown, N. J.). 18 May 1970. 8p. Dep. CFSTI.

Control rod drive leakage problems are investigated. Damage to drive seals is described. Testing procedures for analyzing causes of real damage are reviewed. (D.C.C.)

28951 (DOCKET-50219-74) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 56. (Jersey Central Power and Light Co., Morristown, N. J.). 21 May 1970. 6p. Dep. CFSTI.

A review of the performance of the primary system leak detection method is presented. (D.C.C.)

28952 (DOCKET-50237-42) DRESDEN NUCLEAR POWER STATION, UNIT 2. Modification No. 70-3 to Safety Analysis Report to Allow Concurrent Operation of Units 2 and 3 Ventilation Systems. (Commonwealth Edison Co., Chicago, Ill.). 15 May 1970. 3p. Dep. CFSTI.

28953 (DOCKET-50237-43) DRESDEN NUCLEAR POWER STATION, UNIT 2. Main Steam Isolation Valve Failure. (Commonwealth Edison Co., Chicago, Ill.). 18 May 1970. 3p. Dep. CFSTI.

28954 (DOCKET-50237-44) DRESDEN NUCLEAR POWER STATION, UNIT 2. Control Rod Insertion Time Increase. (Commonwealth Edison Co., Chicago, Ill.). 14 May 1970. 1p. Dep. CFSTI.

28955 (DOCKET-50237-45) DRESDEN NUCLEAR POWER STATION, UNIT 2. Failure of a Relief Valve to Open. (Commonwealth Edison Co., Chicago, Ill.). 22 May 1970. 1p. Dep. CFSTI.

28956 (DOCKET-50237-46) DRESDEN NUCLEAR POWER STATION, UNIT 2. Proposed Change No. 1 to Appendix A of DPR-19. (Commonwealth Edison Co., Chicago, Ill.). 22 May 1970. 4p. Dep. CFSTI.

Revised safety limits for the fuel element cladding and the core are presented. (D.C.C.)

28957 (DOCKET-50244-42) ROBERT E. GINNA NUCLEAR POWER STATION, UNIT 1. Failure of Main Steam Line Isolation Valve to Close. (Rochester Gas and Electric Corp., N. Y.). 22 May 1970. 2p. Dep. CFSTI.

28958 (DOCKET-50249-35) DRESDEN NUCLEAR POWER STATION, UNIT 3. Appendix A to Operating License; Technical Specifications and Bases. (Commonwealth Edison Co., Chicago, Ill.). 14 May 1970. 167p. Dep. CFSTI.

28959 (DOCKET-50261-29) H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2. Proposed Facility Operating License. (Division of Reactor Licensing (AEC), Washington, D. C.). 14 May 1970. 10p. Dep. CFSTI.

For Carolina Power and Light Co., Raleigh, N. C.

28960 (DOCKET-50261-30) H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 18 May 1970. 42p. Dep. CFSTI.

For Carolina Power and Light Co., Raleigh, N. C.

28961 (DOCKET-50263-38) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Preliminary Safety Analysis Report, Amendment 27. (Northern States Power Co., Minneapolis, Minn.). 19 May 1970. 5p. Dep. CFSTI.

Stainless steel cladding for the safe ends of recirculation outlet nozzles is described. The cladding is applied to inner and outer surfaces. (D.C.C.)

28962 (DOCKET-50269-14) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Preliminary Safety Analysis Report, Amendment 12 (Includes Final Safety Analysis Report, Rev. 5). (Duke Power Co., Charlotte, N. C.). 25 May 1970. 246p. (DOCKET-50270-14; DOCKET-50287-11). Dep. CFSTI.

Additional information is presented on the following topics: cooling system safety requirements; seismic stress requirements for containment building; containment building instrumentation; engineered safeguards; containment structure penetrations; control systems; and coolant loss accident analysis. (D.C.C.)

28963 (DOCKET-50280-25) SURRY POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 15. (Virginia Electric and Power Co., Richmond). 25 May 1970. 78p. (DOCKET-50281-25). Dep. CFSTI.

Design parameters of core components are listed. Engineered safeguards are described. Containment system design requirements are presented. Safety limits for reactor systems are included. (D.C.C.)

28964 (DOCKET-50282-20) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Supplementary Information to the Preliminary Safety Analysis Report. (Northern States Power Co., Minneapolis, Minn.). 12 May 1970. 48p. (DOCKET-50306-20). Dep. CFSTI.

Additional information is presented on the following topics: flood hazards for the site; fuel handling and storage facilities; and auxiliary building ventilation system. (D.C.C.)

28965 (DOCKET-50313-20) ARKANSAS NUCLEAR ONE, Preliminary Safety Analysis Report, [Amendment 17], Suppl. 17. (Arkansas Power and Light Co., Little Rock). 12 May 1970. 211p. Dep. CFSTI.

Additional information is presented on the following topics: building arrangements; containment system; engineered safeguards; electrical systems; fuel handling system; plant ventilation systems; meteorological data; and design requirements for prestressing tendons anchorage zones. (D.C.C.)

28966 (DOCKET-50315-18) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Benton Harbor Power Plant Limnological Studies. I., II., and III. (American Electric Power Service Corp., New York). 18 May 1970. 104p. (DOCKET-50316-18). Dep. CFSTI.

28967 (DOCKET-50315-19) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Benton Harbor Power Plant Limnological Studies. IV. (American Electric Power Service Corp., New York). 18 May 1970. 92p. (DOCKET-50316-19). Dep. CFSTI.

28968 (DOCKET-50315-20) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Benton Harbor Power Plant Limnological Studies. V. (American Electric Power Service Corp., New York). 18 May 1970. 11p. (DOCKET-50316-20). Dep. CFSTI.

28969 (DOCKET-50315-21) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Report on Progress in Analyzing the Samples Collected from Lake Michigan. (Michigan Univ., Ann Arbor). 29 Apr 1970. 4p. (DOCKET-50316-21). Dep. CFSTI.

For American Electric Power Service Corp., New York.

28970 (DOCKET-50315-22) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Design Change Report No. 11; Report on Cadweld Stagger in the Unit 1 Containment Structure Foundation Slab. (American Electric Power Service Corp., New York). 26 May 1970. 9p. (DOCKET-50316-22). Dep. CFSTI.

28971 (DOCKET-50333-21) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Construction Permit No. CPPR-71; Federal Register Notice; Initial Decision. (Division of Reactor Licensing (AEC), Washington, D. C.). 10 May 1970. 15p. Dep. CFSTI.

For Power Authority of the State of New York.

28972 (DOCKET-50336-13) MILLSTONE NUCLEAR POWER STATION, UNIT 2. Preliminary Safety Analysis Report, Amendment 9. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). 22 May 1970. 55p. Dep. CFSTI.

Financial data on the owners of Millstone Point Power Reactor, Unit 2 are given in support of the application for construction permit and operating license. Prospectuses are presented for Connecticut Light and Power Company, January 14, 1970, Hartford Electric Light Company, May 6, 1970, and Western Massachusetts Electric Company, April 13, 1970. (D.C.C.)

28973 (DOCKET-50336-14) MILLSTONE NUCLEAR POWER STATION, UNIT 2. ACRS Report. (Atomic Energy Commission, Washington, D. C. Advisory Committee on Reactor Safeguards). 15 May 1970. 4p. Dep. CFSTI.

28974 (DOCKET-50341-8) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 2. (Detroit Edison Co., Mich.). 4 May 1970. 413p. Dep. CFSTI.

Revised information on Fermi Power Reactor Unit 2 is presented under the following broad topics: Introduction and Summary; Site; Reactor; Reactor Coolant System; Containment; Core Standby Cooling Systems; Control and Instrumentation; Electrical Power Systems; Radioactive Waste Systems; Auxiliary Systems;

Power Conversion Systems; Plant Structures and Shielding; and Conduct of Operations. Appendices contain information on: pressure integrity of piping and equipment pressure parts; loading criteria; and conformance to AEC general design criteria. (D.C.C.)

28975 (DOCKET-50341-10) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 4. (Detroit Edison Co., Mich.). 14 May 1970. 125p. Dep. CFSTI.

Proposed complete technical specifications are included. (D.C.C.)

28976 (DOCKET-50346-9) DAVIS-BESSE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 5. (Toledo Edison Co., Ohio). 15 May 1970. 357p. Dep. CFSTI.

Additional information is presented under the following topics: building arrangements; site geology and hydrology; radiation monitoring programs; and engineered safeguards. (D C.C.)

28977 OCONEE NUCLEAR POWER PLANT. Montgomery, D. W. (Babcock and Wilcox, Lynchburg, Va.). Nucl. Eng. Int.; 15: 337-8(Apr 1970).

The 2658 MW(e) PWR station is part of the Duke Power Company's Keowee-Toxaway Project. A 3 unit station, it is the largest private utility yet licensed for construction and will be the most efficient, with an expected net station heat rate of 9951 Btu/kWh. Details of the site are given. (UK)

28978 HEALTH PHYSICS PROBLEMS OF SITING NUCLEAR REACTORS. Bonta, Janos. Nepegeszsegugy; 50: 330-3(Dec 1969). (In Hungarian).

Safety problems related to siting of research and power reactors in Hungary are reviewed. (D.C.C.)

28979 LEAK RATE TEST ON NUCLEAR REACTOR CONTAINMENT VESSEL. Kaneda, A.; Kamisako, M.; Masaki, T.; Koga, T.; Satake, M. (Mitsubishi Heavy Industries, Ltd., Hiroshima). Mitsubishi Juko Giho; 7: 138-47(Mar 1970). (In Japanese).

The outline of a leak rate test conducted at the time of completion of a reactor containment vessel for No. 1 Unit of Mihama Power Reactor is described. The test was conducted by three methods: absolute method, method based on measurement of air weight (a kind of the absolute method) and reference method. In any of these methods, test results have proved that the vessel can fully satisfy its allowable leak rate, "0.1%/24 hrs of the air weight in the vessel." Judging from the results of this test, it is concluded that we can fully rely upon the test by the absolute method. (auth) (NSA of Japan)

28980 COOLING WATER AS A FACTOR IN THE LOCATION OF POWER PLANTS. Vapaavuori, Olavi (Ekono, Helsinki). Sahko; 43: 110-14(Apr 1970). (In Finnish).

The effect on the environment of transferring heat to water depends on how much of the heat can be readily transferred direct to the atmosphere via the water surface, and how much of it remains and continues heating the ambient water mass. The transfer of heat from water to the ambient air and the mixing of hot and cold water are analyzed. The idea of cooling towers and cooling pools for large power plants in Finland is presented. The effect of cooling water from these plants on coastal weather and environment is examined. (auth) (Finland)

Power Reactor Development

Refer also to abstract 27470.

28981 (AECL-2205(Rev.)) NPD: AN ANNOTATED BIBLIOGRAPHY OF PUBLISHED LITERATURE. Radley, D.; Armstrong, F. S. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan 1970. 22p. Dep. CFSTI (U. S. Sales Only). AECL $1.00.

Included are 170 citations to publications on the Nuclear Power Demonstration (NPD) reactor. The publications are listed by date and cover the period from 1955 to 1970. An author index is included. (H.D.R.)

28982 (ANL-7653) FACTORS INFLUENCING DROSS FORMATION IN THE FUSIBLE SEALS OF THE EBR-II ROTATING PLUGS. Ruther, W. E. (Argonne National Lab., Ill.). Jan 1970. Contract W-31-109-eng-38. 15p. Dep. CFSTI.

The factors influencing the rate of dross formation in the fusible seals of the EBR-II rotating plugs were studied in the laboratory using a rotating cylinder in a beaker of the fusible alloy ^{42}Bi wt % Sn. The results indicated that dross formation in a simple rotating system may be a complex process. A single, linear oxidation rate was found for only those few experiments in which the oxidation product did not mechanically interact with the rotor. In the more general case, the mechanical interaction of the dross with the rotating system resulted in substantially greater oxidation rates after an initial period of operation. The oxidation rate during the initial period was shown: to be linearly related to circumferential velocity of the rotor in the range of velocities examined in the EBR-II (0-100 in./min) and to be independent of the rotor size. The secondary oxidation rate, reached after about 600 min, was linearly related to velocity for a given rotor, but was dependent on rotor size. No large effect of alloy composition on the secondary oxidation rate was found when the tin content was varied (37 to 47 wt %) or when aluminum was added. Indium (4 wt %) proved effective in reducing the rate of dross formation in the basic alloy. However, little benefit was derived from the indium addition when sodium (at the level found in the actual seal trough) was added to the alloy containing 4 wt % In. (3 references) (auth)

28983 (ANL-7679) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, MARCH 1970. (Argonne National Lab., Ill.). 27 Apr 1970. Contract W-31-109-eng-38. 178p. Dep. CFSTI.

Highlights of project activities for March 1970 are summarized. LMFBR physics development, component development, and Na technology are reviewed. Operations and analysis of ZPR-3, ZPR-6, ZPR-9, and ZPPR are described. The EBR-2 research and development projects, fuel fabrication, and operations are summarized. Reactor fuels and materials development, physics studies, engineering development, fuel cycle chemistry, and LMFBR safety studies are reported. (D.C.C.)

28984 (GA-8420) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(E) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending December 31, 1967. (Gulf General Atomic, Inc., San Diego, Calif.). 29 Jan 1968. Contract AT(04-3)-633. 205p. Dep. CFSTI.

BLOWERS—development of steam turbine drive helium, for gas cooled reactors
FORT ST. VRAIN POWER REACTOR, UNIT 1—pressure vessel for, stress analysis of prestressed concrete
—cooling system of, flow characteristics for in-core
—core support structures for, stress analysis of
—kinetics of, analysis of accident condition and normal operation
—fuel particles for, fabrication and irradiation testing of coated
—fuel element loading machine for, development of grapple head operated
—blowers for, development of steam turbine drive helium
—control element drives for, development and testing of
—boilers for, flow testing of
NEUTRONS, FAST—effects on coated ceramic particle fuels
PRESSURE VESSELS—stress analysis of prestressed concrete
REACTOR CONTROL ELEMENTS—drives for gas cooled, testing of
REACTOR FUELS—development of coated ceramic particles
—radiation effects on coated ceramic particles, fast neutron
REACTOR LOADING MACHINES—development of grapple head operated gas cooled (D.C.C.)

28985 (GA-8879) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(E) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending September 30, 1968. (Gulf General Atomic, Inc., San Diego, Calif.). 31 Oct 1968. Contract AT(04-3)-633. 194p. Dep. CFSTI.

BLOWERS—development of steam turbine drive helium, for gas cooled reactors
BOILERS—flow stability in gas cooled reactor
FISSION PRODUCTS—release in coated ceramic particle fuels
FORT ST. VRAIN POWER REACTOR, UNIT 1—fuel management for, analysis of optimum
—core materials design requirements for
—fuels for, fabrication and testing of coated ceramic particle
—fuel elements of, fission product release testing for
—fuels for, fast neutron radiation effects on BISO and TRISO coated ceramic particle
—blowers for, development of steam turbine drive helium
—boilers for, flow testing of
NEUTRONS, FAST—effects on BISO and TRISO coated ceramic particle fuels
REACTOR FUEL ELEMENTS—fission product release in coated ceramic particle

REACTOR FUELS—radiation effects on BISO and TRISO coated ceramic particle, fast neutron (D.C.C.)

28986 (GA–9130) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(E) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending December 31, 1968. (Gulf General Atomic, Inc., San Diego, Calif.). 29 Jan 1969. Contract AT(04-3)-633. 251p. Dep. CFSTI.

BLOWERS—development of steam turbine drive helium, for gas cooled reactors
FISSION PRODUCTS—release in coated ceramic particle fuels
FORT ST. VRAIN POWER REACTOR, UNIT 1—pressure vessel thermal barrier for, stress testing of stud attachment fixtures for
—fuel cycle management for, analysis of optimum
—fuel elements of, fission product release testing for
—control elements for, performance of pyrolytic carbon coated boron carbide (B_4C) granule type
—fuels for, fast neutron radiation effects on BISO coated particle type ceramic
—fuel element loading machine for, development of grapple head operated
—blowers for, development of steam turbine drive helium
—control element drives for, development and testing of
—boilers for, flow testing of
NEUTRONS, FAST—effects on BISO coated ceramic particle fuels
PRESSURE VESSELS—thermal barrier of prestressed concrete, stress testing of stud attachment fixtures for
REACTOR CONTROL ELEMENTS—performance of pyrolytic carbon coated boron carbide (B_4C) granule type
—drives for gas cooled, testing of
REACTOR FUEL ELEMENTS—fission product release in coated ceramic particle
REACTOR FUELS—cycle management for gas cooled coated particle, analysis of optimum
—radiation effects on BISO coated ceramic particle, fast neutron
REACTOR LOADING MACHINES—development of grapple head operated gas cooled (D.C.C.)

28987 (GA–9944) HTGR BASE PROGRAM. Quarterly Progress Report for the Period Ending February 28, 1970. (Gulf General Atomic, Inc., San Diego). Mar 31, 1970. Contract AT(04-3)-167. 72p. Dep. CFSTI.

GRAPHITE—diffusion of strontium in, effects of time and temperature on
REACTOR FUEL ELEMENTS—reprocessing cycle for HTGR type
REACTOR FUELS—radiation testing of coated particle ceramic
—fission product release from coated particle ceramic
REACTORS, GAS-COOLED—development of 1000 MW(e) HTGR concept during December 1969 to February 1970
—fuel recycle for HTGR type
—fuels for, development of coated particle ceramic
REACTORS, POWER—development of 1000 MW(e) HTGR concept during December 1969 to February 1970
STRONTIUM—diffusion in graphite, effects of time and temperature on
THORIUM CARBIDES—fission product release from BISO coated particle fuels of
—ThC_2–UC_2, fission product release from BISO coated particle fuels of
THORIUM OXIDES ThO_2—ThO_2–UO_2, stability of BISO coated particles, effects of fluid bed oxidation on
URANIUM CARBIDES—fission product release from TRISO coated particle fuels of
—ThC_2–UC_2, fission product release from BISO coated particle fuels of
URANIUM OXIDES UO_2—ThO_2–UO_2, stability of BISO coated particles, effects of fluid bed oxidation on (D.C.C.)

28988 (KFK–1066) METHODS OF JUDGING NUCLEAR REACTOR DEVELOPMENT ESPECIALLY THE FAST BREEDER. Jansen, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Feb 1970. 454p. (In German). Dep. CFSTI (U. S. Sales Only).

Studies to determine the development tendencies of nuclear power stations in the Federal Republic of Germany are presented. Particular emphasis is laid on a description of the problems associated with models forming the basis of decision preparation, and it is attempted to provide an input for subjective weighting and forecasting factors to the methods of analysis offered. Special economic problems associated with high performance breeders which result especially in a new and comprehensive criterion of Fast Breeder optimization are described. The price of plutonium is analyzed. The plutonium worth is determined for the different power station concepts. An applied systems analysis of the situation of nuclear energy in the Federal Republic of Germany for the coming decades is included. Special significance is assigned to the discussion of the problem of satisfying or reducing the demand with respect to the amount of separative work required to enrich uranium for some types of nuclear power stations. (auth)

28989 (TRG-Report–1996) HIGH-TEMPERATURE REACTOR. McLaren, N. H. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Apr 1970. 15p. Dep. CFSTI (U. S. Sales Only).

In the U. K. the helium cooled high temperature reactor is known as the Mark III GCR, Mark I and II being the Magnox and AGR designs, respectively. The development of the reactor engineering and of the fuel is described. A description of a typical Mark III reactor design is given. (auth) (UK)

28990 NUCLEAR REACTOR SYSTEM. Yevick, John G.; Brill, Edward F. (to Atomic Power Development Associates, Inc.). U. S. Patent 3,506,540. 14 Apr 1970. Filed 30 Oct 1967.

A nuclear reactor is described which has a main plug for the reactor vessel which is in the shape of a section of a hollow square. The outside surface has hemispherical guide holes for locating the subassembly handling equipment. The plug has a plurality of penetrations to provide access to the liners inside the reactor vessel. Small plugs with locking means are provided for the penetrations. The main plug is adapted to receive subassembly handling equipment in sealed relationship and in alignment with the penetrations. (AEC)

28991 CALCULATING AND TESTING THE PERFORMANCE OF NUCLEAR REACTOR INTERNALS. Iansiti, E.; Lazzeri, L.; Messore, G. (CNEN, Rome). pp 185-97 of Performance of Nuclear Power Reactor Components, Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB–240; CONF-691115.

The problem of vibration of reactor internals as a potential origin of accidents or non-availability in nuclear plants is analyzed. In analyzing the nature of the problem, attention should be paid to two directions in which it is possible to find the solution, i.e., good design and careful and extensive inspections. A calculation model to yield the eigenfrequencies and the displacement pattern of the internals is presented. This takes into account the increase in pressure in the fluid as a consequence of the movement of the internals themselves. It is found that generally real reactor structures show large departures from the behaviour in vacuum. The results are compared with some experimental results obtained either on real reactors or on scale models and the agreement is quite promising. The problem of excitation causes is briefly discussed. With regard to the controls, a complete program of inspection should be performed at three different stages of the plant life: plant commissioning, normal plant operation, and periodic plant shut-downs. For each of these different situations it is necessary to use proper methods and care must be given to the effect of ambient situations like pressure, temperature, and radiation level. 4 references. (auth)

Kinetics and Dynamics

Refer also to abstracts 29081, 29082, and 29089.

28992 (AECL-3513) EXPERIMENTAL BUCKLINGS OF "SIMULATED BOILING" H_2O-COOLED 28-ELEMENT NATURAL UO_2 FUEL IN HEAVY WATER MODERATOR. Srinivasan, M.; Serdula, K. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct 1969. 51p. Dep. CFSTI (U. S. Sales Only). AECL $1.50.

Bucklings of "simulated boiling" H_2O-cooled 28-element natural UO_2 fuel assemblies in heavy water moderator were determined using the few rod substitution technique in the ZED-2 critical facility. Boiling coolant was simulated by bubbling air through H_2O in a maximum of seven assemblies in the central test zone of a 55 assembly core. Coolant density was varied by adjustment of air flow rate and addition of minute quantities of a surface tension reducing agent. The purpose of the experiment was to obtain bucklings for coolant density values between the limits of 1.0 and 0 g/cm^{-3}. Measurements were carried out at six different coolant densities in this range. The critical heights of the substituted cores were analyzed by the source-sink theory code

MICRETE 3, following the procedure developed at the Chalk River Nuclear Laboratories. Within experimental errors results indicate a linear variation of buckling with coolant density between the end point values. An interesting outcome of this experimental program was the technique of three region substitution. It was found that use of a two region pseudo-reference core, wherein the central test region contained buffer fuel assemblies of known spectral properties which more closely matched those of the test fuel, had advantages. In this case progressive substitution resulted in three region cores and resultant test fuel bucklings were more consistent. (14 references) (auth)

28993 (KR-138) BURNAPAN: A FORTRAN CODE FOR DEPLETION OF BURNABLE POISONS INSIDE A CYLINDRICAL PIN WITH ANISOTROPIC NEUTRON INCIDENCE. Zaalouk, M. Gamal (Institutt for Atomenergi, Kjeller (Norway)). Nov 1969. 54p. Dep. CFSTI (U. S. Sales Only).

The basic physics analysis and programming of the Burnable Poison Depletion Code BURNAPAN are presented. This is a one dimensional code which calculates the space and depletion dependent flux inside a cylindrical pin containing a highly absorbing (thermal) material (Gadolinium). The calculation assumes polyenergetic, anisotropic neutron flux incident on the surface of the pin. From the obtained flux distribution the self-shielding factor, effective macroscopic absorption cross section, and poison content are calculated as functions of neutron flux time. Associated with the program is a library program LIBRAGAD which calculates the energy dependent microscopic absorption cross sections of the Gadolinum isotopes ^{155}Gd, ^{157}Gd and provides a table of energy integral functions to be used with the BURNAPAN code. For comparison purposes, the depletion calculation using the neutron transport code K-7 JAN-THERMOS is also presented. (15 references) (auth)

28994 (PEL-183) WELWING: A FORTRAN IV COMPUTER CODE FOR BUCKLING CALCULATIONS ON CYLINDRICAL FUEL ELEMENTS. Koster, A. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). May 1969. 45p. Dep. CFSTI (U. S. Sales Only).

The computer program was developed to calculate the material buckling of reactor systems consisting of annular fuel elements in heavy water as moderator. An analytical solution of the one-group diffusion equations is given and the various corrections and approximations applied are fully described. The results obtained agree well with experimental data for annular fuel elements containing natural U as well as for solid fuel elements of slightly enriched U. 6 references. (auth)

28995 (RD/B/N-1579) WHIST: A PROGRAM FOR PROCESSING WIMS OUTPUT. Johnson, P. W. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Lab.). Jan 1970. 21p. Dep. CFSTI (U. S. Sales Only).

Much of the manual processing of the output from WIMS which was developed for multigroup lattice calculations, and also of the WIMSD version, is eliminated by use of the facility WHIST. WHIST will read WIMSD history tape, carry out a lifetime calculation, including the estimation of rating histories, and will also produce lattice data in CRAM and FLEET forms together with graphite damage rates. 6 references. (UK)

28996 (RT/FI-(69)23) HETEROGENEOUS MOCKUP OF PLUTONIUM WITH EUROPIUM IN A LATTICE OF URANIUM. Orestano, F.; Pistella, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 22 Apr 1969. 77p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The features of a natural uranium fueled lattice containing Eu have been defined in order to mock-up—as far as the neutron spectrum is concerned—a reference Pu fueled lattice. The results of calculations are reported for the irradiation experiment of the Eu lattice in the RITMO reactor. For different patterns of the lattice detailed calculations of power distributions as well as of spectral index distributions have been performed. 33 references. (auth)

28997 (WAPD-TM-938) ON THE USE OF EFFECTIVE DELAYED NEUTRON FRACTIONS FOR FEW-GROUP SPACE-TIME ANALYSIS (LWBR DEVELOPMENT PROGRAM). Yasinsky, J. B.; Foulke, L. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr 1970. Contract AT-11-1-GEN-14. 47p. Dep. CFSTI.

An examination is made of the energy group dependence of the few-group time-dependent diffusion theory model for multiple fissionable isotope bearing reactors. Specific emphasis is on the adequacy of effective delayed neutron fractions to improve the accuracy of the few-group solutions. Numerical results indicate that space-time independent effective delayed neutron fractions can represent adequately the delayed to prompt neutron importance effects and account for the local presence of two different fissionable isotopes. (11 references) (auth)

28998 (WAPD-TM-941) A VERSATILE EIGENVALUE METHOD FOR CALCULATING $\bar{\beta}_i$ WITH BE-21. (LWBR Development Program). Foulke, K.; Schmidt, E.; Natelson, M. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr. 1970. Contract AT-11-1-GEN-14. 13p. Dep. CFSTI.

A method is described which uses the program BE-21 to calculate effective delayed neutron fraction, $\bar{\beta}_i$, for individual spatial regions of reactors with more than one fissionable isotope. The chief virtue of the method is that it may be used as a standard for testing other prescriptions for calculating $\bar{\beta}_i$. Example calculations of $\bar{\beta}_i$ for a seed-blanket reactor indicate the insensitivity of $\bar{\beta}_i$ to flux tilting. (3 references) (auth)

28999 SOME MONTE CARLO TECHNIQUES FOR THE CALCULATION OF DOPPLER COEFFICIENTS. Miller, L. B. (Argonne National Lab., Ill.); Miley, G. H. Nucl. Sci. Eng.; 40: 438-48(Jun 1970).

A Monte Carlo method for the analysis of the Doppler effect has been developed which employs special perturbation techniques to compute effects due to changes in both the temperature and the diameter of fuel rods. These techniques facilitate the application of Monte Carlo to this type of problem and make possible the elimination of approximations inherent in earlier analytic and numerical methods. Numerical results obtained by this method are in good agreement with previously reported measurements on ZPR-3. The method has been applied to the study of the effect of fuel diameter on the Doppler coefficient in a typical fast reactor. Reducing the fuel diameter in a Na-cooled uranium-carbide reactor from 0.30 to 0.15 cm was found to increase the Doppler coefficient 13%. (19 references) (auth)

29000 PHYSICS OF FAST REACTORS. I. Bustraan, M. Atoomenergie Haar Toepass.; 12: 57-69(Feb 1970). (In Dutch).

The differences in the physics and engineering problems of thermal and fast reactors are discussed, followed by a classification of cross sections, indicating their significance for the performance of the reactor. Smoothed neutron-energy spectra for fissionable and breeder materials are presented as a function of the cross section data. This is followed by a review of the breeding ratios, relating the $\eta - 1$ values of various elements to the cross section ratios. Included is an examination of the neutron energy spectra for the Na I and D I reference reactors, covering also the structural materials (Inconel, Incoloy), the coolants (sodium and steam), and fission products as a function of absorption and capture processes. Reactions of several isotopes in various areas and materials of the D I reactor are presented in tabular form, defining and calculating the doubling times of both reactor types. (TTT)

Control Systems

Refer also to abstracts 27468, 28874, and 29084.

29001 EFFECT OF NEUTRON ANISOTROPY ON THE DEPLETION OF A CYLINDRICAL BURNABLE POISON PIN. Zaalouk, M. G. (Atomic Energy Establishment, Cairo); Berg, J. O. Nucl. Sci. Eng.; 40: 472-7(Jun 1970).

An analysis is presented for calculating the depletion characteristics (poison effective cross section, self-shielding, and spatial-flux distribution) of a cylindrical pin containing one isotope or a mixture of burnable poison isotopes. The analysis takes into consideration the anisotropy of incident neutrons. The resulting equations are programmed on a digital computer, and the results are in good agreement with the transport-theory calculations of the depletion. One of the particular merits of the presented analysis is the high degree of accuracy achieved and the shorter computation time required in comparison to similar transport-theory methods. To illustrate the method, sample calculations are performed for a cylindrical fuel pin containing 5% (wt%) gadolinium in a typical Boiling Water Reactor core lattice. (9 references) (auth)

29002 CONTROL RODS FOR WATER REACTORS. Synder, H. J. Nucl. Eng. Int.; 15: 350-2(Apr 1970).

A short survey is presented of the basic requirements of control rods for nuclear reactors dealing with function of the rod, its geometric forms, rod engineering requirements, methods of fabrication, irradiation effects, and economic influence. Rod properties and characteristics of control rod materials are emphasized. (auth)

29003 IMPROVEMENTS IN OR RELATING TO GRAPHITE MODERATOR STRUCTURES FOR NUCLEAR REACTORS.

Dale, Walter Bernard (to United Kingdom Atomic Energy Authority). British Patent 1,191,152. 6 May 1970. Filed 25 Apr 1967.

A graphite moderator brick is described having holes drilled therein to allow fluid access, with at least some of the holes partially filled by graphite inserts shaped to allow divided peripheral flow in the holes. The graphite insert may take the form of a square section rod with its corners contacting the wall of the hole; the corners of the rod may be rounded to match the contour of the wall. A hexagonal-section insert is also considered suitable. (UK)

Cooling Systems

29004 (EURFNR-701) COOLANT BOILING IN SODIUM-COOLED FAST REACTORS. Schlechtendahl, E. G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-1020. 145p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The Na boiling in the narrow geometry of a fuel element of a Na-cooled fast reactor is studied. The study is limited to the cases in which the coolant channel geometry is not perturbed by tubular cladding widening or deposition of extraneous substances. The typical differences of liquid metal boiling phenomena from those of water are theoretically interpreted. Boiling is described analytically. Results of calculations with the BLOW 2 core are compared with test results. Very good agreement is found for the growth of the first bubble. In the further course of vaporization and condensation, deviations occur which are clearly due to the assumption of thermodynamic steady-state in the longitudinal direction of the bubble. While boiling delay is the crucial parameter for the growth of the first bubble, the behavior of the residual liquid film on the heating surface is of great importance for the subsequent oscillating movements of the bubble. For selected in-pile coolant perturbations, vapor bubble dynamics are studied and interpreted with regard to their importance for reactor safety. 81 references. (auth)

29005 MEASUREMENT OF SHOCK STRAIN AND DEFORMATION IN SHOCK-RESISTANCE STRUCTURE OF A FAST REACTOR. Ueda, Shuzo; Uchida, Takashi (Japan Atomic Energy Research Inst., Ibaraki). Collect. Lect. Pap., Jap. Soc. Mech. Eng.; No. 212, 203-6(Aug 1969). (In Japanese).

With the purpose of obtaining data necessary for the safety analysis of a fast reactor, shock strain and deformation were measured for the scale-down models of a reactor vessel and its associated plug-bolt. The models used were $\frac{1}{10}$ and $\frac{1}{5}$ of the actual size, made of SS 41 and SUS 27; and the bolt was of cold steel. The bottom was platter-shaped, and the top was in the form of a plug which was fixed with the bolts. Simulating Na coolant, the vessel was filled with water, with an air layer of 25 to 100 mm thick at the top. The explosive was set off in the middle of the vessel by an electrical detonator. The usefulness of the models was confirmed through the estimate of deformation mechanism by measuring the shock strain due to in-water explosion with a strain meter. Plastic strain was measurable up to 2%. Deformation occurred near the upper flange of the vessels due to water hammering several msec after the deformation caused by the explosion shock-wave; therefore the vessel as a whole took double bulged shape. (NSA of Japan)

29006 GAS ELUTION IN THE FIRST CIRCUIT OF WATER-COOLED NUCLEAR REACTOR WITH GASEOUS PRESSURIZER. Bychkov, N. V.; Kasperovich, A. I. At. Energ. (USSR); 28: 145 (Feb 1970). (In Russian).

The parameter Δt_w, the temperature variations at the point of the system, and boiling of the water at assigned general pressure in the circuit are described. It is assumed that the solubility of gas is in direct ratio to Δt_w. The curves of nitrogen solubility in water as a function of temperature at $p_0 = p_g + p_p = \text{const}$ t° are presented. (R.V.J.)

29007 BYPASS-CYCLE TREATMENT OF THE PRIMARY WATER CIRCUIT OF PILOT REACTORS. Nagy, O. Kut. Intez. Kiadv.; No. 90, 1-114(1967). (In Hungarian).

The following problems were investigated in connection with the primary water circuit of nuclear reactors serving purposes of research and power generation: circumstances under which fixed bed or continuous ion-exchange equipment is practical for bypass-cycle treatment; which factors must be considered for selecting the necessary power; and justification for the regeneration of ion exchangers. Starting from the testing of water purifiers consisting of cation and anion exchangers the differential equation characterizing the operation of bypass-cycle purifiers was derived and checked. Bypass-cycle treatment has been found suitable for use in open-circuit primary systems both from operational and economic aspects. It is not economical to regenerate smaller plants at the site, rather the ion exchangers should be connected in series for their full exploitation and regeneration should be made at the factory. (Hung. Tech. Abstr.)

29008 PRIMARY CIRCUIT PUMPS OF POWER REACTORS. Lepert, C. (Etablissements Pompes Guinard, Saint-Cloud, France). pp 141-7 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

Pumps are described for the primary circuits of nuclear power reactors. The water type (PWR or BWR types), light or heavy water, and those cooled with liquid metals are included. In the case of the light-water type, a brief examination of the completely air-tight pumps used, for example, in the PWR type to drive ships, shows that they are unsuitable for land-based reactors. The primary pumps of these reactors are described and analysed on the basis of the following criteria: performance, safety, investment and operating costs, reliability and maintenance. In the case of reactors cooled with liquid metal, the design of the pumps is linked with that of the reactors, whether or not they are integrated. These pumps are also described and analysed on the basis of the above-mentioned criteria. (auth)

29009 PILOT EXPERIMENTS FOR ASSESSING THE RELIABILITY OF MECHANICAL AND ELECTRO-MECHANICAL COMPONENTS AND SYSTEMS DURING OPERATION. Basile, D.; Schweitzer, G.; Volta, G. (EURATOM, Ispra, Italy). pp 215-33 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

An overall description is presented of the techniques and procedures implemented at the EURATOM Joint Research Centre at Ispra to develop an effective system for quantitative evaluation of the reliability of a reactor primary circuit. This work particularly concerns the primary circuits of pressure-tube reactors moderated with heavy water. The problems discussed are: identification of the components so as to achieve a uniform statistical basis; a description of the conditions of use; the collection and working up of data during operation; preventive detection of faults. 6 references. (auth)

29010 ADVANCES IN STEAM GENERATOR DESIGN. Fritz, K.; Lippitsch, J. (Waagner-Biro AG, Vienna). pp 347-60 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

Operating experience of all indirect-cycle reactor types has shown the importance of the steam generator for plant availability and reliability. Advances in the design of steam generators for existing and future reactor types are discussed with emphasis on PWR, HTGR and breeder reactors (with both gas or liquid metal cooling). The severe demands on component reliability have required a change in the approach regarding thermal assessment. One of the salient features is the consideration, already in the assessment stage, of the dynamic and transient behaviour of the steam generator among others as a basis for refined methods of stress analysis. In the field of heat transfer and fluid flow, important improvements of the state of art have been achieved regarding two-phase flow, heat transfer geometry, local temperature deviations, and flow mixing in tube bundles. Plant availability depends to a considerable extent on the steam generators, tube failures being a typical reason for steam generator down-time. The possibility of quick repair of such tube failures is one of the main criteria for high availability. Factors governing this aspect, such as individual tube runs which allow single tubes to be plugged easily, have to be considered at the design stage. A completely different approach calls for a steam generator design in which units or modules can be removed and replaced easily. Aspects concerning the manufacture of steam generators are discussed: the influence of the material selection on fabrication methods; workshop installations; clean conditions; quality control. Some emphasis is laid on production sequence and scheduling. 21 references. (auth)

29011 PROGRESS AND RESULTS OF THE RELIABILITY STUDY OF PRESSURE VESSELS. Kellermann, O. A.; Mieze, G.; Slopianka, G.; Tietze, A. (Technische Ueberwachungs-Vereine eV, Cologne). pp 391–403 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

A reliability study of conventional pressure vessels has been initiated. The objective is to obtain fairly accurate failure rate data of heavy, thick-walled pressure vessels and to extrapolate as far as possible for nuclear pressure vessels. The first step of the study, an estimation of the failure rate of conventional pressure vessels, has been completed and has given us a knowledge of the order of magnitude of the failure rate data. The second step was concerned with thick-walled boiler drums. The results from this investigation are more representative for nuclear pressure vessels than those from the first step. Thus this work is described in more detail. The causes of the failures are analysed and the failure modes discussed. An attempt is being made to extrapolate on nuclear pressure vessels from this data and to discuss its consequences. 3 references. (auth)

Fuels

Refer also to abstracts 28857 and 28864.

29012 (GA–10012) HTGR FUEL IRRADIATION PERFORMANCE AND IMPLICATIONS ON FUEL DESIGN. Goeddel, W. V.; Winkler, E. O.; Luby, C. S. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 23, 1970. Contracts AT(04-3)-633; AT(04-3)-167. 21p. (CONF-700401-2). Dep. CFSTI.

From Gas-Cooled Reactor Program Information Meeting, Oak Ridge, Tenn.

The fuel element design for large HTGRs is a hexagonal graphite block containing coated particles in bonded fuel rods. The excellent irradiation performance of the multilayered BISO and TRISO coated particles has been demonstrated in 250 successful tests to burnups up to 59% FIMA, fast fluences up to 8.7×10^{21} n/cm^2, and temperatures up to 1450°C. Beds of coated particles bonded into fuel rods with carbonaceous matrices have been demonstrated to be stable during 18% FIMA burnup and 6×10^{21} n/cm^2 fast fluence at 1250°C. Irradiation testing of the reference graphite has shown it to have adequate dimensional and structural stability over the full range of HTGR operating conditions. 16 references. (auth)

29013 (KFK–1118) FUEL RODS WITH INNER RIBS. A POSSIBILITY FOR LOWERING THE FISSIONABLE MATERIALS REQUIREMENTS IN FAST BREEDER REACTORS. Malang, S.; Rust, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Dec 1969. 36p. (In German). Dep. CFSTI (U. S. Sales Only).

For two types of fuel elements the temperature distribution within the rods was calculated under various conditions. One type of rod possessed inner ribs of Incoloy running lengthwise. The second type has a cam plate arrangement in horizontal position. At the same central temperature, efficiency of rods with inner ribs was 25% and that with cam plates was 50% higher than that of conventional fuel rods. Variations of height, volume, and number of ribs as well as fuel element diameter, fuel density, and heat transfer between fuel and cladding showed that the highest achievable power output is determined predominantly by the height of the ribs. Moreover, the highest achievable efficiency, conversely to conventional fuel rods, increased with diameter. Therefore, new considerations for optimal rod diameter were necessary. (H.B.G.)

29014 (LA–4231) PHENIX: A TWO DIMENSIONAL DIFFUSION-BURNUP-REFUELING CODE. O'Dell, R. Douglas; Hirons, Thomas J. (Los Alamos Scientific Lab., N. Mex.). Jun 1969. Contract W-7405-eng-36. 121p. Dep. CFSTI.

PHENIX is a two-dimensional, multigroup, diffusion-burnup-refueling code for use with fast reactors. The code is designed primarily for fuel-cycle analysis of fast reactors and can be used to calculate the detailed burnup and refueling history of fast breeder reactor concepts having any generalized fractional-batch reloading scheme. Either ordinary k_{eff} calculations or searches on material concentrations or on region dimensions can be performed at any time during the burnup history, using the standard source iteration technique. The refueling option of the code accounts for the spatial flux shifts over the reactor lifetime in the calculation of fuel discharge. All programming is in FORTRAN-IV, and the storage requirements are designed so that the code fits in a 64k memory of a CDC-6600 computer. 5 references. (auth)

29015 (LA–4393) LOADING OF SODIUM-BONDED FUEL CAPSULES. Dunning, D. N. (Los Alamos Scientific Lab., N. Mex.). 24 Feb 1970. Contract W-7405-eng-36. 16p. Dep. CFSTI.

Equipment and procedures are described for assembling experimental, sodium-bonded LMFBR fuel pins and other capsules associated with the Los Alamos Scientific Laboratory (LASL) mixed carbide fuel program. Details of the system used for supplying sodium of known and controllable quality are given along with sodium analytical equipment and procedures. Also included are procedures for the handling and inspection of (U,Pu)C fuel and the bonding of fuel pellets to stainless steel cladding. Analyses of supply sodium and glovebox gas are shown. (auth)

29016 (ORNL–TM–2970) CALCULATED RADIOACTIVITY OF MSRE FUEL SALT. Bell, M. J. (Oak Ridge National Lab., Tenn.). May 1970. Contract W-7405-eng-26. 21p. Dep. CFSTI.

Calculations have been made of the inventory and radioactivity of the fission product and transuranium isotopes present in the MSRE fuel salt. The calculations have included operation with both ^{235}U and ^{233}U fuels, the effect of stripping of noble gases, and fluorination of the fuel salt after the period of ^{235}U operation. Results are presented which give the inventory and radioactivity of individual isotopes in the salt up to January 1, 1975. (8 references) (auth)

29017 (RD/B/N–1595) DEVELOPMENT OF IMPROVED HEAT TRANSFER SURFACES. PART III. AIR RIG TESTS ON CHAMFERED RIBBED SURFACES. Warburton, C. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1970. 20p. Dep. CFSTI (U. S. Sales Only).

Heat transfer and pressure drop tests on a range of surfaces roughened by widely-spaced, chamfered transverse ribs show that a worthwhile improvement in performance can be obtained if the rib height is reduced below the present AGR value or if the rib volume is increased. A surface with the same volume as AGR and an 18% lower rib showed a gain in Stanton number of 5%. The best surface tested had a total volume equivalent to an increase in AGR can volume of 5%. Allowing for changes in Stanton number and friction factor this surface showed a gain in performance of 9.5%. The best chamfer angle for this type of surface is about 12°. (auth) (UK)

29018 (TID–25419) LMFBR FUEL ROD DESIGN LIMITS AND TRANSIENT SURVIVAL CRITERIA. Carelli, Mario D.; Anderson, Carl A. Jr.; Markley, Robert A. (Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Reactors Div.). [nd]. Contract AT(30-1)-4135. 4p. Dep. CFSTI.

Design limits such as maximum allowable cladding and fuel temperatures and tolerable amount of molten fuel are calculated for LMFBR fuel rods. The performance of the fuel elements under normal and off-normal transient conditions is analyzed. (D.C.C.)

29019 (WAPD-TM–618(Add.2)) FIGRO (ADDENDUM II): A CDC-6600 COMPUTER PROGRAM FOR THE ANALYSIS OF FUEL SWELLING AND CALCULATION OF TEMPERATURE IN BULK-OXIDE CYLINDRICAL FUEL ELEMENTS (LWBR DEVELOPMENT PROGRAM). Goldberg, I.; Lynn, L. L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Apr 1970. Contract AT-11-1-GEN-14. 22p. Dep. CFSTI.

The FIGRO computer program calculates temperatures and fuel swelling in bulk-oxide cylindrical fuel elements. The addition of heat conduction model for the analysis of rapid transients such as those encountered in hazards and safeguards studies is described. Other additions account for the effect on gap conductance of the release of volatile gases from the fuel, reduction of gap thickness due to clad creep, ternary fission helium release, and the existence of clad corrosion layers. FIGRO now requires 100,000 octal locations to run on the CDC-6600 SCOPE 3.1 operating system. A sample problem is presented. (7 references) (auth)

29020 BURNABLE POISON DISPERSION IN UO_2 FUEL. Flipot, A. J.; Van den Broeck, H.; Delbrassine, A.; Gilissen, R. (MMN, Dessel, Belg. CEN/SCK, Mol, Belg.). Nucl. Eng. Int.; 15: 345–9(Apr 1970).

Incorporation of burnable poisons in the form of a uniform dispersion into UO_2 was studied in order to increase the life-time of fuel elements. The Belgian–French PWR reactor of the SENA plant at Chooz was selected as a model for the preliminary neutronic calculations. TiB_2 and $Dy(BO_2)_3$ are not compatible with UO_2 but Dy_2O_3 does not give any compatibility problems. Short irradiation experiments were made in the BR2 reactor at high linear power output and Dy_2O_3 was found to be a convenient burnable compound both for its neutronic properties and for its metallurgical properties. (auth)

29021 FACTORS AFFECTING THE COST OF NUCLEAR FUELS AND THE SELECTION OF REACTOR FUEL CYCLES IN THE DEVELOPING COUNTRIES. Wordsworth, A. D.; Cowherd, S. J. (Kennedy and Donkin, Woking, Eng.). pp 317-38 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The influence of economic conditions in the developing countries, and to some extent in several industrialized countries, has a marked effect on the selection of a specific type of reactor system which can be economically attractive when integrated into a national network. When one considers that the accumulated fuel costs for a typical proven-type reactor will more or less equal the plant investment costs within the first half of the designed life of the plant, the relationship of the fuel cost to the total energy cost structure becomes of even greater importance. The growing tendency of many of the developing countries towards independence in the peaceful nuclear field presents many problems in the supply and economics of nuclear fuels, particularly when enrichment, reprocessing and reconversion form parts of the over-all fuel cycles. The various fuel requirements and costs for present-day and future reactor types, and the different methods of supply which are now available from sources outside a developing country are discussed. The factors affecting local manufacture of fuels are discussed, and the foreseen costs and effects on the total energy cost structure are presented. Variations in internal and external finance requirements and interest rates are also discussed. The effect on fuel costs of the introduction of dual- and multi-purpose nuclear complexes in which electricity production is combined with fresh-water production, district heating supplies and services for industry and agriculture is examined. The socio-economic benefits of these are discussed, and the influence of nuclear fuel costs on the total cost structure is investigated. (auth)

29022 LONG-TERM NUCLEAR FUEL CYCLE AND ITS ECONOMICS RELATING TO PLUTONIUM UTILIZATION. Kikuchi, T. (Science and Tech. Agency, Tokyo). pp 365-83 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

It is well known that the selection of a combination of reactor types on a long-term basis is a strategic topic with regard to a nation's nuclear power-generating system from the viewpoint of the optimum utilization of plutonium. Plutonium is very important, not only for its contribution to the power-generating cost of thermal reactors by providing a credit of more than 3% of the cost, but also because of the intermediate utilization of plutonium for a thermal reactor until the introduction of a FBR to the power-generating system. The plutonium balance of demand and supply is also a major factor influencing the nuclear fuel cycle and its economics. The effect of plutonium utilization on the nuclear fuel cycle and its economics is evaluated by means of systems analysis, and the result can be applied to an evaluation of the comprehensive plutonium strategy. The calculation model adopted for the systems analysis can be used for the following studies: Plutonium thermal use up to the introduction of the FBR into the nuclear power-generating system; successful development of plutonium self-sustaining type reactors; plutonium importing; and the introduction of uranium-loading FBRs owing to plutonium deficiency after the inclusion of FBRs in the nuclear power system. (auth)

29023 OPERATING PERFORMANCE OF THE MZFR ON-LOAD FUELLING MACHINE. Schabert, H. P.; Weber, R. (Siemens AG, Erlangen, Ger.). pp 15-22 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

A brief description of the MZFR fueling machine and its operating record is presented. The machine has refueled more than 230 reactor channels while the reactor was on load and has remained in good working condition. Several important features of its design are discussed and evaluated in the light of the experience accumulated. Conclusions are drawn for the fueling machine design of future large D_2O reactors. 2 references. (auth)

Operation and Economics

29024 (AECL-3066) ECONOMIC RELATIONS BETWEEN FAST AND HEAVY WATER POWER REACTORS. Lewis, Bennett W. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar 1970. 11p. (DL-82; CONF-670995-1). Dep. CFSTI (U. S. Sales Only). AECL $0.50.

From American Nuclear Society Meeting, Detroit, Mich.

Heavy water reactors are the best friends of fast reactors in the immediate future because (1) they will serve to keep the price of U down, (2) they can produce Pu both most plentifully and most cheaply. Comparisons are charted and discussed to examine the total U requirement, fuel cycles and processing costs in the two reactor types. Use of heavy water natural U reactors would help fast reactors to secure their initial fuel inventory at the lowest cost. Very large capacity heavy water reactors seem likely to be built ahead of fast power reactors that could achieve the same economy of scale. Fast reactor development is still at the stage where a 350 MW(e) prototype has yet to be built. Heavy water reactors will live happily with good fast breeders that produce a surplus of cheap Pu as that can be a second fuel. Alternatively, if the fast reactor itself can be combined in design with a D_2O and Th system so that the extra neutrons are supplied directly, they could make a combination with extremely low total fueling costs. Increased prices for U would then have a minor effect. (auth)

29025 (GEAP-10010-23) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Twenty-Third Quarterly Report, November 1969-January 1970. Pflasterer, G. R.; Becker, R. A. (comps.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Feb 1970. Contract AT(04-3)-540. 36p. Dep. CFSTI.

Startup tests are described. Reflector worths are presented. Flow and pressure coefficients of reactivity are measured. Operations and maintenance requirements during November 1969 to January 1970 are listed. (5 references) (D.C.C.)

29026 EFFECT OF VARIOUS FACTORS ON THE COST OF GENERATING ELECTRICITY IN FAST REACTORS USING A SODIUM COOLANT. Lytkin, V. B. (Inst. of Atomic Energy, Moscow). pp 63-74 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970). (In Russian).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

In the near future fast-neutron power reactors will become one of the main power-plant types, ensuring large-scale nuclear power production with the minimum consumption of materials. The economics of atomic power plants with fast reactors depend on a number of factors, which need to be considered when the optimum parameters of such plants are chosen. The expenditure on the fuel cycle of fast reactors is examined, since it is the magnitude of the fuel component of the power cost on which the economics of a reactor of this type to a great extent depends. The high value of the fuel removed from the reactor and the unavoidable delay in recovering its cost make it imperative to consider the time factor in working out the fuel component of the generating cost per kilowatt-hour. How the fuel component is influenced by factors such as specific power of the fuel, fuel burn-up, extent of coolant heating, fuel type, and fuel reprocessing time is considered. The analysis is made both from the point of view of calculated expenditure and from that of calculated uranium requirements in the initial stages of a system based on fast uranium and plutonium reactors. The latter method enables the cost of plutonium, which is difficult to determine, to be ignored. The main lines along which work should be done to improve the fuel-cycle characteristics in order to reduce electricity generating costs are indicated. (auth)

29027 ECONOMICS OF FIRST-GENERATION HIGH-TEMPERATURE REACTORS AND FUTURE PROSPECTS. Gutmann, H. (Atomic Energy Establishment, Winfrith, Eng.); Daub, J.; Schober, H.; Graziani, G.; Zanantoni, C. pp 75-87 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The high-temperature reactor (HTR) is introduced as a nuclear power plant with heat exchangers and steam turbines that show very good economics on the basis of low enriched uranium cycles for the first stations to be built in Europe during the next few years and which are expected to go on full power between 1975 and 1977. About that time the HTR could also become commercially available for the developing countries. Total electricity generating costs are given, including presently realistic fuel fabrication and capital cost estimates based on commercial assessments provided confidentially by the European nuclear industries and selected according to the principle that only tech-

nical and economic considerations determine the choice of contractors. The cost survey is given with respect to the limiting design parameters. The costs are calculated for the size of the first power plants that will be built in Europe as well as for plants of half of that size that will be of more interest in the developing countries. Though the costs of the various reactor and fuel fabrication components cannot be disclosed, the breakdown of the total generating costs into overall capital, operating, fabrication costs, as well as inventory and current fuel-cycle costs, is given for several power densities and fuel irradiation times. As a prospect of future development, which is of general interest to all countries because of its potential of cheaper costs, and of particular interest to those developing countries with large thorium findings, the HTR as an advanced converter on the basis of thorium/uranium fuel cycles, is investigated. A concluding discussion sums up the various prospects of HTRs in general terms with a special view to their use in developing countries. (auth)

29028 STEAM-GENERATING HEAVY-WATER REACTOR. Ghalib, S. A. (Nuclear Power Group Ltd., Knutsford, Eng.). pp 89-100 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

Taking advantage of a relatively late entry into the water-reactor field, the United Kingdom has been able to combine the best features of earlier water reactors in the steam-generating heavy-water reactor. The attractive economics of this system arise from the following intrinsic features: The use of light-water coolant and the direct cycle, coupled with a particularly simple construction, leads to a potentially low cost system; the pressure-tube construction simplifies access for refuelling and permits the reactor to operate with a low fuel inventory, so economizing in fuel costs; the use of heavy water as a separate unpressurized moderator gives a good neutron economy and helps to reduce fuel costs; and the pressure-tube construction using factory prefabricated units makes the reactor particularly attractive in smaller unit sizes and for remote sites. These features and how they lead to a system which is particularly suited to the requirements of developing countries are examined. (auth)

29029 OUTLOOK FOR MOLTEN-SALT POWER REACTORS. Rosenthal, M. W.; Briggs, R. B.; Kasten, P. R. (Oak Ridge National Lab., Tenn.). pp 101-14 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

Molten-salt reactors (MSRs) are being developed by the United States of America for generating low-cost power while extending our resources of fissionable fuel. The fluid fuel in these reactors, consisting of UF_4 and ThF_4 dissolved in fluorides of beryllium and lithium, is circulated through a reactor core moderated by graphite. The successful operation of the 8-MW(t) Molten-Salt Reactor Experiment (MSRE) has demonstrated that operation with such a type of fuel is practical, that the salt is stable under reactor conditions, and that corrosion is very low. Processing of the MSRE fuel has demonstrated that MSRs can operate as high-performance converters. New fuel processing methods under development should permit MSRs to operate as economical breeders. These features, combined with high thermal efficiency (44%) and low primary system pressure, give MSR converters and breeders favourable economic fuel utilization, and safety characteristics. Further, these reactors can be initially fuelled with ^{233}U, ^{235}U, or plutonium. The construction cost of an MSBR power plant is estimated to be about the same as that of light-water reactors, leading to power costs about 0.5 to 1.0 mill/kWh less than those for light-water reactors. The proposed steps in developing commercial MSBRs include construction of a breeder reactor experiment having high-performance features and the construction of converter power reactors using already demonstrated technology. These efforts should lead to full-scale MSBRs having the desired characteristics. (auth)

29030 ECONOMIC ASPECTS OF HIGH-TEMPERATURE REACTORS. Schloesser, J.; Schroeder, E. (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). pp 305-14 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The design characteristics of a commercial high-temperature pebble-bed reactor are described. The main components of the primary circuit are discussed and compared with those of the Thorium High-Temperature Reactor (THTR), a 300-MW(e) prototype to be built in 1970. Secondly, the expected total generating costs are quoted. Capital costs and fuel-cycle costs are indicated according to various economic ground rules. For the capital costs, special consideration is given to the economy of size. The fuel cost is based both on the uranium and the thorium cycle. Its dependence on re-fabrication facilities and on the requirement of natural uranium and separation work is described. Finally, costs and other characteristic data of a high-temperature reactor are compared with those of a light-water reactor and a conventional oil-fired station. (auth)

29031 NUCLEAR POWER: A BASIS FOR REGIONAL ECONOMIC DEVELOPMENT. O'Donnell, A. J.; Licciardo, R. B, A. (Bechtel Corp., San Francisco). pp 385-99 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The increasing use of nuclear power throughout the world offers a unique opportunity for promoting regional economic and industrial development. This concept is most frequently conceived in the form of nuclear-power-supported industrial-agricultural complexes (NUPLEX). A different theme utilizing the western rim of the Pacific Basin as a case study is developed. By 1980 approximately 30,000 MW(e) will be generated by nuclear power stations planned by six countries on the western rim of the Pacific Basin. Although the majority of this nuclear generating capacity will be based upon enriched uranium reactors, natural uranium systems are expected to play a role. Commercial fast breeders will start being of significance in the mid-1980s. The nuclear fuel requirements for this installed capacity in 1980 would require an investment of about $700 million in facilities for the conversion of uranium oxide to UF_6, for enrichment, for fuel fabrication and fuel reprocessing. The annual operating costs for these facilities will be approximately $350 million. The opportunity exists for the countries of the western Pacific Basin to co-operate in the construction and operation of the uranium fuel-cycle facilities required to meet the needs of the region. With the exception of Japan, these countries would be unable to support individual nuclear fuel-cycle facilities to meet their own national needs at that time. Consequently, they have a choice: build and operate facilities on a regional cooperative basis; or continue to depend upon the major nuclear powers to supply the services needed. The first alternative offers considerable opportunity for regional industrial and economic development. (auth)

29032 PROJECTION OF NUCLEAR-FUEL COST TRENDS. Hoffmeister, A. J.; Houser, H. G.; Smith, E. E. (Westinghouse Electric Corp., Pittsburgh). pp 401-12 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

The light-water reactor fuel cycle is analyzed by the discrete elements of which it is composed and future economic trends for each of these elements are projected. It is contended that (a) as the volume of light-water fuel being processed increases, and (b) as engineering advancements and materials developments and improved utilization combine to provide higher recovery of available energy content, light-water fuel-cycle costs will decrease considerably. It is further contended that the effects of inflation, if it continues in the future, will strongly influence the fossil versus nuclear plant economic balance in favour of the nuclear plant. (auth)

Safety and Siting

29033 (ANL-7498) TWO-DIMENSIONAL HYDRODYNAMICS ANALYSIS FOR PRIMARY CONTAINMENT. Chang, Yao-Wen; Gvildys, Joseph; Fistedis, Stanley H. (Argonne National Lab., Ill.). Nov 1969. Contract W-31-109-eng-38. 93p. Dep. CFSTI.

A numerical method is described for calculating the two-dimensional hydrodynamic response of a primary reactor containment system to a high-energy excursion. Equations of hydrodynamics and equations of state of reactor materials are expressed in Lagrangian form and then set into finite-difference equations. Shock discontinuities are eliminated by the use of the von Neumann–Richtmyer pseudoviscosity, q. These equations, along with pressure pulse and other pertinent input data, are programmed for solution on the IBM-360 computer. Propagation of shock waves, loads imposed on different parts of the reactor components, and the resulting damage are determined at every time step until the steel vessel ruptures or the force acting on the rotating shield plug exceeds the strength of the plug holddown

device. Calculated displacements and pressures at all spatial points at any instant of time also are given in pictorial form. (11 references) (auth)

29034 (BMI-1881) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report for January-March 1970. Carbiener, Wayne A.; Ritzman, Robert L. (Battelle Memorial Inst., Columbus, Ohio). Apr 1970. Contract W-7405-eng-92. 26p. Dep. CFSTI.

FISSION PRODUCTS—release from reactor core during coolant loss accidents, (T)
REACTOR FUEL ELEMENTS—cladding for, effects of coolant loss accidents, (T)
REACTOR SAFETY—coolant loss accidents in water cooled reactors, analytical description of
REACTORS, BOILING—coolant loss accidents in, evaluation of data for analytical description of
—fuel element cladding for, effects of coolant loss on swelling of, (T)
—kinetics calculations for, comparison of point and spatial
—coolant loss accidents in, burst release of fission products from uranium oxide (UO_2) fuels during, (T)
—emergency core cooling system performance in, effects of fuel element swelling on, (T)
REACTORS, PRESSURIZED WATER—coolant loss accidents in, evaluation of data for analytical description of
—fuel element cladding for, effects of coolant loss on swelling of, (T)
—kinetics calculations for, comparison of point and spatial
—coolant loss accidents in, burst release of fission products from uranium oxide (UO_2) fuels during, (T)
—emergency core cooling system performance in, effects of fuel element swelling on, (T)
URANIUM OXIDES UO_2—fission product release from fuels of, effects of coolant loss accidents on, (T) (H.D.R.)

29035 (BNWL-1295) VOID FRACTION PROFILE IN A NUCLEAR REACTOR VESSEL DURING COOLANT BLOWDOWN. Wilburn, N. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr 1970. Contract AT(45-1)-1830. 147p. Dep. CFSTI.

An experimental and analytical study of the phenomena that occur in the reactor vessel and piping during a postulated accidental loss of coolant from a light water cooled nuclear power reactor is discussed. The study of liquid-vapor in a vessel and the consideration of the two-phase flow which occurs in the outlet pipe or orifice are analyzed. The liquid-vapor action during blowdown (with top, middle and bottom nozzles) from a vessel without internal structures is studied. (17 references) (auth)

29036 (IN-1386) PRESSURIZED WATER REACTOR-FULL LENGTH EMERGENCY COOLING HEAT TRANSFER (PWR-FLECHT) TESTS PROJECT. Haire, J. C.; Brockett, G. F. (Idaho Nuclear Corp., Idaho Falls). Apr 1970. Contract AT-(10-1)-1230. 28p. Dep. CFSTI.

The PWR-FLECHT Project is designed to provide experimental data from 12-ft-long electrically heated rod bundles for use in determining emergency core cooling system performance during a loss-of-coolant accident. The project will provide data from which heat transfer correlations can be developed to predict the thermal response of PWR cores from the time emergency core coolant fills the lower core plenum until the core is reflooded. Maximum temperature rises and temperature arrest times are presented with respect to the cold flooding rate in a stainless steel-clad, electrically heated rod bundle. Heat transfer coefficients are given for various bundle elevations with respect to time after flooding. The temperature-time behavior is also given for one test performed with a Zircaloy-clad, electrically heated rod bundle. Portions of the project remaining to be performed include tests with both stainless steel- and Zircaloy-clad heater bundles. Tests with stainless steel-clad heaters will be performed to determine the minimum flooding rates permissible in current ECC system designs, the effect of flow blockage with up to 16 subchannel flow areas completely blocked, and the effect of variable flow reflooding. Tests employing Zircaloy-clad heaters will be performed to determine ECC requirements at high temperatures. Test results currently available from stainless steel-clad bundles show that if reflooding systems provided for current generation pressurized water reactors deliver water to all areas of the core at design conditions, they are capable of terminating the initial core thermal transients initiated by a loss-of-coolant accident. (8 references) (auth)

29037 (KFK-1057) THEORETICAL TREATMENT OF CONCEIVABLE SEVERE ACCIDENTS WITH FAST BREEDER REACTORS IN THE SCOPE OF BETHE-TAIT MODELS. Kluge, F. G.; Thurnay, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Sep 1969. 67p. (In German). (EUR-4314). Dep. CFSTI (U. S. Sales Only).

The maximum energy release following a large accident of the fast power reactor is usually calculated with the Bethe-Tait formalism. The version presented is adopted to spherical and to cylindrical geometries; the excursion calculations take account of the delayed neutrons and of the Doppler-feedback, including the fuel-melting process. A formalism for determining the destructive energy is also incorporated. Parameter calculations have been carried out to cover up the uncertainties in the initial values of the excursions; the results are presented and discussed. A critical survey on the main assumptions of the Bethe-Tait formalism has been added. (20 references) (auth)

29038 (ORNL-TM-2919) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT FOR JANUARY-FEBRUARY 1970. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). May 1970. Contract W-7405-eng-26. 161p. Dep. CFSTI.

AEROSOLS—behavior in reactor containment structures, effects of accident conditions on, (T)
CHARCOAL—combustion of, effects of fission product decay heat on
GRAPHITE—corrosion by steam
INFORMATION CENTERS—operation of Nuclear Safety, during January to February 1970
IODINE—removal from containment structures by basic borate spray system, (EIT)
—sorption on metal surfaces of high temperature gas cooled reactor cooling system, effects of particle size and flow velocity on
LIQUID METAL FAST BREEDER REACTOR—fuel element assemblies of, effects of bundle configuration on failure characteristics of
METHANE, IODO—sorption by pression suppression containment systems, effects of coolant loss conditions on
NOZZLES—stresses in multiple and single cylindrical and spherical shell connected, effects of configuration on
NUCLEAR SAFETY PILOT PLANT—spray systems for, removal of elemental iodine by basic borate spray, (E/T)
PIPE FITTINGS—stress analysis for ASA B 16-9 tees, (E)
REACTOR CONTAINMENT STRUCTURES—aerosol behavior in, effects of accident conditions on, (T)
REACTOR CONTAINMENT SYSTEMS—performance of pressure suppression, effects of coolant loss conditions on methyl iodide sorption
REACTOR FUEL ELEMENTS—swelling of Zircaloy clad rod type, effects of coolant loss conditions on
REACTOR FUELS—fission product release from TRISO coated uranium oxide (UO_2), effects of coating failure on
REACTOR SAFETY—research and development program during January to February 1970, analysis of ORNL
REACTORS, GAS-COOLED—core of high temperature, effects of steam on graphite
—cooling system for high temperature, adsorption of iodine on metal surfaces of
REACTORS, POWER—core of high temperature gas cooled, effects of steam on graphite
—cooling system for high temperature gas cooled, adsorption of iodine on metal surfaces of
SPRAYS—effectiveness of basic borate, for removal of elemental iodine from containment structures, (EIT)
STANDARDS—development of reactor engineering, by USAEC
STEAM—corrosive effects on graphite
STEEL—tensile properties of A533 HSST, (E)
ZIRCALOY—mechanical properties of, measurement of high temperature (D.C.C.)

29039 STUDIES OF PHENOMENA CONNECTED WITH THE DEPRESSURIZATION OF WATER REACTORS. Edwards, A. R. (United Kingdom Atomic Energy Authority, Risley, Eng.); O'Brien, T. P. J. Brit. Nucl. Energy Soc.; 9: 125-35(Apr 1970).

New concepts are described to explain the violent phase change effects associated with the sudden depressurization of a water-cooled power reactor. This new approach is based on the conduction-controlled heat transfer to a cloud of bubbles and is being checked by experimental depressurization tests on simple pipe systems. Instrumentation was developed to measure pressure disturbances over a frequency range of at least 0 to 36 kHz in water at temperatures up to 650°F. An X-ray absorption system was developed for measuring transient void growth with an estimated accuracy of ±0.03 void fraction in the complete range 0 to 1 at intervals of 2 to 3 ms. Some experimental results are presented and it is shown that the new theoretical treatment can

reproduce very closely the early stages of the depressurization of a 3 in. nominal bore pipe about 13 ft long. (auth) (UK)

Research and Test Reactors

Refer also to abstracts 27292, 27465, 28978, 28983, 28996, 29007, and 29083.

29040 (ANL-7534) GASOUT: THE CODE USED TO CALCULATE GASEOUS FISSION PRODUCT RELEASE FOR A ZPR-6 AND -9 DESIGN BASIS ACCIDENT. Swanson, C. D.; Bohn, E. M. (Argonne National Lab., Ill.). Jan 1970. Contract W-31-109-eng-38. 48p. Dep. CFSTI.

Program GASOUT calculates the amount of noble gas and radioiodine fission products expelled into the atmosphere following a ZPR-6 and -9 "Design Basis Accident." Tabulated values of fission product activities following fission are combined with a calculation of time-dependent cell pressure to determine the number of fission product atoms released. This information can then be used to determine the radiological hazard to a man standing downwind from the reactor during the accident. The code is written for the IBM 360/50/75 computer. (4 references) (auth)

29041 (BNWL-1214) FABRICATION REPORT [OF THE] FFTF PROTOTYPIC FUEL PELLETS FOR ANALYTICAL CHEMISTRY PROGRAM. Blair, H. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr 1970. Contract AT(45-1)-1830. 53p. Dep. CFSTI.

Approximately 4000 sintered, 25 wt% PuO_2-75 wt% UO_2, FFTF type fuel pellets were fabricated in the initial test of the FFTF Fuel Pin Fabrication Development and Demonstration Facility. The materials, equipment, techniques, and sampling used in the fabrication are described. Complete characterization of the sintered pellets including dimensions, density, chemical composition, and homogeneity is reported. The sintered pellets have an average density of 91.35% TD and an average oxygen-to-metal ratio of 1.99. The pellets are homogeneous, and no evidence of the existence of more than one phase was detected. The O/M of 200 of the sintered pellets was reduced to 1.96. One hundred of the pellets were centerless ground for use in determining pellet density by geometrical methods. (6 references) (auth)

29042 (BNWL-1330) FFTF PROCESS DATA DISPLAY PROTOTYPE. Dozer, B. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr 1970. Contract AT(45-1)-1830. 44p. Dep. CFSTI.

Interfacing of a four-color cathode ray tube display to a digital computer is described. Interface diagrams and a description of operation are provided. It is concluded that with appropriate display routines available such a display system is a valuable control room device. (5 references) (auth)

29043 (BNWL-1347) DYNAMIC SIMULATION OF PRIMARY LOOP CHECK VALVES FOR THE FAST FLUX TEST FACILITY. Krajicek, J. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. Contract AT(45-1)-1830. 15p. Dep. CFSTI.

A dynamic simulation digital program for FFTF primary loop check valves of the tilting disk or swing check types has been developed. The model considers all moments acting on the valve disk. Included are the inertial, pivot-pin friction, valve disk weight, torsional spring, fluid, and damping moments. The developed check valve logic can be added to a previously developed digital program for dynamic simulation of the entire reactor and primary loops. The dynamic response of the system using the combined programs is shown for typical accidents. (5 references) (auth)

29044 (BNWL-1352) CALCULATION OF THE REACTIVITY CHANGE FROM VOIDING THE HEAVY WATER COOLANT OF THE PLUTONIUM RECYCLE TEST REACTOR. Maryott, James Lee (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 44p. Dep. CFSTI.

A method is developed for calculating the reactivity worth of the heavy water coolant of the Plutonium Recycle Test Reactor (PRTR). The coolant reactivity worth is determined by calculating the effective multiplication constant of the reactor core with and without the coolant in given process tubes. The calculational method includes a method for calculating the resonance integrals for PRTR circular 19-rod cluster fuel elements based on the experimental resonance integral data for single UO_2 fuel rods and hexagonal 19-rod clusters of UO_2 fuel rods. The calculational method is evaluated by comparing the theoretical results with experimental coolant reactivity measurements previously obtained at the PRTR. The accuracy of the calculational method is shown to be within the experimental accuracy of the cross section data by calculating the reactivity change produced by the change in each individual multigroup cross section. (18 references) (auth)

29045 (CONF-690540-, pp 87-96) A-41 MEASUREMENTS IN THE ENVIRONS OF THE EIDGENOESSISCHES INSTITUTE FOR REACTOR RESEARCH IN WUERENLINGEN, SWITZERLAND. Nagel, E. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). (In German).

Throughout several years, ^{41}Ar release from the 70m high stack of the DIORIT reactor was measured under various meteorological conditions. Within a radius of 1 to 3 km from the reactor, maximum dose rates of 20 μrem/hour were found; occasionally, dose rates of 100 μrem/hour were observed. Wind velocities above 3m/second carried detectable radioactivity over 300m high ridges and up to a distance of 8 km from the reactor. In no case, however, did the ^{41}Ar activity reach hazardous levels. Findings are presented in five diagrams. (H.B.G.)

29046 (CONF-690540-, pp 113-18) A SIMPLE MEASURING ARRANGEMENT FOR THE MONITORING OF EMISSION OF ^{41}Ar. Jahn, H. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Forschungsreaktoren). (In German).

A continuous monitoring apparatus was designed for the research reactor FRJ I and FRJ II to study production and release of ^{41}Ar in the experimental channels. Mean activities ranged from 100 mCi/hour to 1 Ci/hour. Flushing of the channels following high neutron flux showed transient activities up to 20 Ci/hour. To reduce such activity peaks, the experimental channels were flushed with CO_2 which flowed through a coiled plastic hose 2000 m in length before being released in the exhaust air system. The hose length delayed release of ^{41}Ar by about 4.3 hours and, thereby, reduced its activity by a factor of five. (H.B.G.)

29047 (CONF-690540-, pp 126-40) EXPERIENCE IN THE MONITORING OF RADIOACTIVITY, ESPECIALLY OF RADIOIODINE IN THE EXHAUST AIR OF THE EIR. Chen, D. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). (In German).

Exhaust air from hot cells and from the DIORIT reactor was monitored especially for radioiodine. The commonly employed paper filters gave unreliable results. A new device, consisting of two chambers filled with activated charcoal, was developed and tested for the retention of ^{131}I and methyl iodide. Efficiency of the device was almost 100%. For about one year the method was employed with good results for monitoring the DIORIT reactor and hot cells. Method and findings are presented in six diagrams. (H.B.G.)

29048 (GEAP-5722) FINAL FAST FLUX TEST FACILITY BACKUP DESIGN SUMMARY REPORT. Pluta, P. R. (comp.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Jan 1969. 430p. Dep. CFSTI.

Design parameters are presented under the following broad topics: nuclear characteristics; core; control rod drives; driver fuel instrumentation facilities; head design for the FFTF backup reactor; shielding and radiation levels; vessel; system dynamic analysis; safeguards; and refueling cell and fuel handling. (D.C.C.)

29049 (GEAP-13588) RESULTS OF SEFOR ZERO POWER EXPERIMENTS. Noble, L. D.; Mitzel, F.; Sarma, B.; Wintzer, D.; Lu, Y. S.; Kessler, G.; Pflasterer, G. R.; Becker, R. A.; Mansur, L. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Mar 1970. Contract AT(04-3)-540. 244p. Dep. CFSTI.

The results of the low (zero) power tests are presented and are compared with calculations. The agreement between experiment and calculation is generally good. The tests were conducted at low power and included such experiments as the approach to the minimum critical core size, calibration of the reflector control, measurement of fission rate distributions, material reactivity worth measurements, uniform non-nuclear heating of the reactor to determine the reactivity temperature coefficient, and the measurement of the ratio (l/β) of the prompt neutron lifetime to the effective delayed neutron fraction. (87 references) (auth)

29050 (GEMP-742) ANALYSIS OF EBR-II NEUTRON SPECTRA BY MONTE CARLO AND DISCRETE ORDINATE METHODS. Edwards, W. E.; Henderson, W. B.; Baumgardt, N. R. (General Electric Co., Cincinnati, Ohio. Nuclear Systems Programs). Dec 1969. Contract AT(40-1)-2847. 374p. Dep. CFSTI.

Two dimensional multigroup fluxes per MW of power in the EBR-II Reactor, computed by Monte Carlo and by discrete ordinate methods, are presented. These fluxes, together with evaluated n,p cross sections for ^{58}Ni, ^{54}Fe, and ^{46}Ti were used to correlate core-length dosimetry data obtained from these sensors in rows 2 and 7 of the EBR-II with stainless steel in the inner radial blanket. The effect on flux distribution and effective sensor cross

sections of replacing the stainless steel with depleted U was also calculated. Results are presented. 31 references. (auth)

29051 (KURRI-TR-64) ON THE THERMAL NEUTRON EXPOSURE TUBE OF KUR. (Kyoto Univ. (Japan). Research Reactor Inst.). [1969]. 12p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

The thermal neutron exposure tube, E-2 tube, of KUR is frequently utilized by biologists, chemists, and other researchers for irradiation by thermal neutrons. Recently, an exposure device was mounted on this tube in order that the insertion and the withdrawal of a sample for irradiation during the reactor operation could be possible with negligible radiation dose to handlers. The details of its structure and the results of the measurement of neutron flux and γ-ray dose rate in this device are described. (auth)

29052 (ORNL-TM-3000) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, JANUARY-MARCH 1970. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). 14 May 1970. Contract W-7405-eng-26. 20p. Dep. CFSTI.

Operations and maintenance requirements during January to March 1970 are presented. Modifications for reactor components are described. (D.C.C.)

29053 (RT/FI-(67)7) FIRST CRITICALITY AND CALIBRATION EXPERIMENTS OF THE RC-4 RITMO REACTOR. Pedretti, E. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 190p. Dep. CFSTI (U. S. Sales Only).

The experiments performed with the RITMO Reactor from its first criticality, achieved on July 9, 1965, to the determination of reference reactor properties, completed at the end of November 1966, are described. Results obtained by the application of the source-drop technique for the calibration of control rods are presented. (12 references) (auth)

29054 (RT/FI-(69)21) CALCULATION OF THE POWER EXCURSION IN THE WATER-MODERATED ROSPO REACTOR Conversano, R.; Lombardi, N.; Sacco, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 26 Feb 1969. 62p. (In Italian). Dep. CFSTI (U. S. Sales Only).

An analysis is made of the power excursion generated in the water-moderated ROSPO reactor, as a consequence of a nuclear accident caused by an increase in the moderator water level. The effects on the power generation of the safety system are also considered. The analysis was carried out by means of an analogue computer. 10 references. (auth)

29055 (SRRC-37/70) ANNUAL REPORT, 1968-1969. Wilson, H. W. (Scottish Research Reactor Centre, East Kilbride (Scotland)). Jan 1970. 19p. Dep. CFSTI (U. S. Sales Only).

Research projects, reactor operations, and educational programs are reviewed for October 1968 to September 1969. (D.C.C.)

29056 (Y-DR-27) THE REACTIVITIES OF HIGH FLUX ISOTOPE REACTOR FUEL ELEMENTS 73 THROUGH 86: MEMO NO. 9. Johnson, E. B.; Reedy, R. K. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 15 May 1970. Contract W-7405-eng-26. 5p. Dep. CFSTI.

29057 ANALYSIS OF CENTRAL REACTIVITY WORTHS IN FAST CRITICAL ASSEMBLIES. Karam, R. A.; Dance, K. D.; Nakamura, T.; Marshall, J. E. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 40: 414-23(Jun 1970).

An integral transport method was developed and applied to the calculation of the central reactivity worths of various samples measured in a 2700-liter uranium-carbide fast core and in a 4000-liter UO_2 fast core. The method was used to obtain corrections to multigroup first-order perturbation calculations, incorporating self-shielding effects inside and outside the sample, as well as scattering, fission and edge-effect perturbations. Resonance interaction between a ^{238}U sample and the ^{238}U in the core as well as resonance self-shielding in the sample itself were explicitly considered. A similar treatment was used for ^{235}U samples. ENDF/B data were used in all of the analyses. The calculated central worths of ^{10}B and tantalum were in very good agreement with the measured values, indicating that the calculated value of β_{eff} used to convert percent $\Delta k/k$ to period measurements was reasonably accurate. The calculated worths of ^{235}U were 5 to 10% greater than the measured values. The discrepancy between the calculated and measured values for ^{238}U was 15 to 20%. The discrepancy for graphite in particular and scatterers in general was rather large, indicating that the distribution of the adjoint function is not adequately calculated. (auth)

29058 TECHNOLOGIC EQUIPMENTS OF THE NUCLEAR REACTOR WWR-CM FOR SOLID BODY PHYSICAL RESEARCHES AT LOW TEMPERATURES. Balla, Janos. Energ. Atomtech.; 22: 495-507(Oct 1969). (In Hungarian).

The performance of a nuclear reactor in experiments with solids at low temperatures using He coolant at 4.2°K is described. The design and construction of equipment for assembly and regeneration of He, He cryostat, He input tubes, pumping control, and special Dewar vessels for storing and transporting liquid He are discussed. It is noted that the use of liquid He coolant expanded the range of reactor operations from the temperature limits of 78°K with liquid nitrogen to 4.2°K. (R.V.J.)

29059 A CRITICAL REVIEW OF OPERATING EXPERIENCE WITH THE BR-3 PLANT. Potemans, M. (SCK-CEN, Mol, Belg.). pp 453-69 of Performance of Nuclear Power Reactor Components. Vienna; International Atomic Energy Agency (1970).

From Symposium on the Performance of Nuclear Power Reactor Components, Prague, Czechoslovakia. See STI/PUB-240; CONF-691115.

The BR-3 PWR at Mol, a 40.9 MW(th), 11.45 MW(e) pilot plant, started to deliver power to the Belgian grid in October 1962. The construction of this plant was intended to allow Belgian industry to gain experience in the nuclear field; and to train utility company personnel for future nuclear plants. Power has been produced with various cores: the original core of Westinghouse design, the reshuffled original core, the second core of Anglo-Belgian design and the reshuffled second core. The latter is at present in operation. Pure light water and varying mixtures of heavy and light water have been used as moderator and coolant. Operation results, incident analysis and experience with equipment, operation, control and training of personnel are reviewed. (auth)

Rocket and Space Reactors

Refer also to abstract 27289.

29060 (AI-AEC-12909) REACTIVITY EFFECTS OF ^{155}Gd ON A SNAP REACTOR. Dray, B. J.; Heneveld, W. H.; Rhoades, W. A.; Rooney, K. L.; Swanson, V. A.; Thiele, A. W. (Atomics International, Canoga Park, Calif.). 15 Apr 1970. Contract AT(04-3)-701. 110p. Dep. CFSTI.

The SNAPTRAN-1 Reactor, a SNAP 10A reactor specially adapted for high-temperature and transient experiments, was used in the operational reactor phase of the ^{155}Gd experiments program. This reactor is capable of operating at temperatures up to 1400°F and of step reactivity insertions of more than $1.50. The reactor is fueled with 37 uranium/zirconium-hydride elements and is reflected with beryllium. The ^{155}Gd was mixed with a nickel powder to serve as a substrate, and rolled and formed into sleeves that were slipped over the individual fuel elements in the core. The experimental program consisted of reactivity measurements at room temperature and elevated temperatures followed by a series of power transients producing significant temperature change to determine the prompt temperature coefficient. These measurements were repeated (with the exception of one prompt coefficient) for each of three concentrations of ^{155}Gd in the core. The reactivity loss with Gd addition was found to be an almost linear relationship with no observed saturation effect. The expected change in temperature coefficient was found, extrapolating to a value of zero or slightly positive prompt coefficient at the highest concentration of gadolinium ($\Sigma_a t = 0.23$). Under the operating limits of the reactor this configuration was not used in the transient temperature-coefficient measurements. The transient experiments also showed that ^{155}Gd made the temperature coefficient less negative, and the amount of the effect increased with increasing temperature. Since the highest Gd concentration was not tested in the transient testing program, the results were inferred by extrapolation. In such case the prompt coefficient would become positive at about 1050°F. (9 references) (auth)

29061 (N-70-11900) A DESIGN STUDY FOR A THERMIONIC REACTOR POWER SYSTEM FOR A NUCLEAR ELECTRIC PROPELLED UNMANNED SPACECRAFT. Quarterly Progress Report, February 4-May 5, 1969. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 23 May 1969. Contracts NAS7-100; JPL-952381. 74p. (NASA-CR-106993; GESP-7011). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

The technical progress of a design study program on thermionic reactor power systems for nuclear electric propelled, unmanned spacecraft is discussed. The purpose is to provide designs of selected thermionic power systems integrated with nuclear electric unmanned spacecrafts over the range of 70 to 500 kW(e). The basic program task structure and key guidelines are presented.

Detailed characteristics of the mercury ion thruster, science payload and communications subsystems are given. Titan 3 C/7 launch vehicle restraints on shroud size and payload capability are discussed, and a point-of-departure 300 kW(e) powerplant design concept is developed in sufficient detail to permit initiation of preliminary analyses of spacecraft weight distributions and activated coolant dose rates. An evaluation of heat rejection systems shows that a two-loop system (the reactor coolant loop in series with the radiator coolant loop, with an intermediate heat exchanger) is approximately 550 pounds heavier than a single-loop system. A coolant activation analysis, based upon a bonded wet cell trilayer reactor powerplant, demonstrates that the two-loop spacecraft power system is required. (auth) (STAR)

29062 (N-70-12176) A DESIGN STUDY OF A THERMIONIC REACTOR POWER SYSTEM FOR A NUCLEAR ELECTRIC PROPELLED UNMANNED SPACECRAFT. Quarterly Progress Report, May 5-August 5, 1969. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 20 Aug 1969. Contracts NAS7-100; JPL-952381. 137p. (NASA-CR-107008; GESP-7013). CFSTI. For Jet Propulsion Lab., Pasadena, Calif.

Radiator configurations were evaluated in terms of the additional structure required to survive the launch environments imposed by the Titan 2 C/7 launch vehicles. The conical radiator was preferred as it provides the maximum initial mass in earth orbit and needs the minimum structural addition relative to a spacecraft nominally optimized for thermal performance. This configuration, to be integrated with the spacecraft and launched in the upright position, requires the minimum parasitic launch support structure of about 4.3 pounds/kW(e) of gross unconditioned power (GUP) for the 300 kW(e) GUP in-core thermionic reactor power plants. Since 240 kW(e) conditioned power is required for the thruster subsystem, this weight penalty may also be expressed as about 5.4 pounds/kW(e) of net power plant. It is recommended that the standard launch shroud be eliminated and the radiator used as the primary shroud, with a special shroud designed to cover the reactor during launch. (STAR)

29063 (N-70-12923) A STUDY OF HEAT PIPE APPLICATIONS IN NUCLEAR AIRCRAFT PROPULSION SYSTEMS. Final Report. Silverstein, Calvin C. 1 Dec 1969. Contract NAS3-11841. 110p. (NASA-CR-72610; SIL-104). CFSTI.

Preliminary studies of heat pipe systems for reactor-to-jet engine heat transport and for emergency distribution of reactor afterheat over the surface of the reactor containment vessel are described. The reactor-to-jet engine heat transport system includes 5480 small-diameter reactor heat pipes, four large-diameter adiabatic heat transport pipes, and 8300 small-diameter heat pipes in each of the four engine heat exchangers. The total system weight is about 47,000 lb. The emergency afterheat distribution system includes 4280 heat pipes 1 in. in diameter and 11.7 in. long, whose total weight is 3400 lb. (auth) (STAR)

29064 (SWRHL-46-r) PARTICULATE EFFLUENT STUDY. PHOEBUS 1B, EP-IV. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Apr 1970. 53p. Dep. CFSTI.

A study concerned with delineating the physical and chemical characteristics and possible hazards associated with release of particulate matter (greater than several microns in diameter) from the Phoebus 1B, EP-IV reactor run conducted February 23, 1967, was conducted. The reactor test was part of the Project Rover Program and was conducted at Jackass Flats, Nevada. The particle deposition occurred in a general northerly direction from the test cell. Particles were found out to 82 miles with the results indicating a decrease in deposition (particles/unit area) with distance to about the 2.5 power. The particle size distribution, of all the particles collected, is reasonably described by a log normal distribution with a geometric mean diameter of about 12μ and a geometric standard deviation of 2.7. A breakdown of the size distribution to those particles 10μ and above gave a geometric mean of 26μ and geometric standard deviation of 2. The density of 8 particles (12 to 28μ) was found to be about 11 g/cc. This density indicates an equivalent aerodynamic geometric mean diameter of about 40μ. Thus, the majority of the particles found and studied were larger than an equivalent diameter of 10μ, the usual cut-off for lower respiratory tract penetration. A regression analysis indicated a decrease in particle size and activity with distance. Isotopic results showed a large degree of fractionation of the fission products found in the particles. Electron microprobe analysis indicated uranium, carbon, and oxygen to be present in most of the particles analyzed. Particles were transported into the off-site area. The resulting ground concentrations were about 1 particle/100 m^2 or less and there was no known interaction of particles with people from the general population. Thus it is concluded there was no hazard to the public from the "particulate effluent." (auth)

29065 DUST CURTAIN IN GASEOUS CORE NUCLEAR REACTORS FOR ROCKETS. Liu, V. C. (Univ. of Michigan, Ann Arbor). Nature (London); 226: 351-2(25 Apr 1970).

In a proposed type of gaseous reactor the gaseous mixture sustains a vortex flow which results in a peaked concentration of the fuel at an appropriate radial distance from the axis of the cylindrical cavity, with very small concentrations at the cavity wall and on the axis. The containment of the fuel suspension in the cavity is achieved by the balance between the differential centrifugal force set up and the diffusional drag of the fuel against the radially inward flowing propellant. Conceptually, the propellant gas diffuses radially inwards through the hot dense annular cloud of fissioning fuel and then flows out axially through a nozzle in the center of one end wall. Extensive theoretical and experimental studies have been made to determine the feasibility of this technique. One of the limiting factors is the deposition of fission fragments, β-rays and thermal radiation on the cavity wall. With a view to reducing these losses the concept of a "dust curtain" in the cavity of a gaseous vortex reactor is introduced. Seeding of the propellant with refractory metal particles is very effective in increasing both opacity to the radiation flux and the collision cross section for the fission fragments; but the seeding material is a poor substitute for propellant from the point of view of optimum engine performance, and for this reason it would be desirable to have the seeding particles suspended and retained in the cavity, rather like the fuel particles without being constantly ejected with propellant through the exhaust nozzle. It has been found that seeding particles, appropriately granulated in mass and size, premixed and injected with the propellant in vortex flow, can be made to have a peaked concentration in an annular region at a specific radial distance from the axis of the cylindrical cavity. This annular seeding particle cloud is referred to as a "dust curtain" and is located between the surface of maximum fuel concentration and the wall, to shield the latter from the fission fragments. In the studies described the kinetics of small suspended particles in a non-uniform gas are considered, including the steady two-dimensional flow of a binary mixture of inviscid gases under the envisaged conditions, leading to formulation of the desirable concentration distribution of the dust in the flowing propellant. (UK)

29066 NUCLEAR POWER SYSTEMS FOR SPACECRAFT. Lafleur, Joseph D. Jr. (Atomic Energy Commission, Germantown, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Aerospace Electron. Syst.; AES-6: 147-64(Mar 1970).

A comparison of the weights, sizes, and costs of nuclear and non-nuclear spacecraft power systems is presented and discussed. Nuclear power systems include the range below 10 kW, with an electrical output to weight ratio of 0.5 to 1.0 pounds per watt. Comparisons show that primary batteries are lighter for short-duration missions of a few hours; fuel cells are lighter for durations of one to two months; and solar-cell/secondary battery combinations are to be preferred when sunlight is adequate. (10 references) (auth)

Process Heat and Desalination Reactors

Refer also to abstracts 28889, and 28904-28907.

29067 (ORNL-TM-2964) PROPOSED DUAL-PURPOSE NUCLEAR DESALTING PLANT USING SINGLE-EFFECT DISTILLATION. Jones, John E. Jr.; Anderson, Truman D. (Oak Ridge National Lab., Tenn.). May 1970. Contract W-7405-eng-26. 37p. Dep. CFSTI.

A novel and conceptually simple dual-purpose nuclear desalting plant is proposed. The evaporator is a single-effect vertical tube "still" (VTS) which operates on very low-temperature (109°F) steam. This "still" is placed between the turbine exhaust and the condenser of a conventional nuclear power plant. It is estimated that the water production cost for the proposed plant would be 38% less than for the best alternative dual-purpose plant using a high-temperature multieffect evaporator. The cost savings result from lower heat cost, elimination of feed-water treatment, reduced pumping power, and the use of aluminum tubes and a concrete shell in the low-temperature evaporator. Based on a preliminary evaluation of the concept, no serious technical questions are apparent. Although the product split between power and water production is strongly biased toward power, there appear to be a number of applications for the proposed plant in populated regions of developed countries. The VTS dual-purpose plant applies current

or near-term technology with a minimum of development required. 10 references. (auth)

29068 COSTS OF NUCLEAR DESALINATION FOR ENERGY CENTRES. Spiewak, I.; Hammond, R. P. (Oak Ridge National Lab., Tenn.). pp 423-34 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

An analysis is given of recent estimates of energy and desalted water costs to show the comparative importance of fuel costs, capital costs and other components of energy and water costs. The effect of parameters such as plant size, interest rate, cost escalation, and level of technology is presented. Those areas which give the best hope for reducing water cost are discussed, including the advantages of scale and of improved technology. The influence of cost escalation and of higher interest rates on desalination projects is compared with their influence on the cost of alternative water sources. Surface water developments, which are most capital intensive and have the longest construction time, are hurt most by rising money costs. Groundwater projects, which generally have low capital cost and short construction time, are least affected. Desalination projects are intermediate. The advantages and disadvantages of dual-purpose plants are discussed, and a description given of presently feasible routes to water-only plants. These include the vapour-compression process and high-temperature evaporators. For widely useful, low-cost desalination plants to be available, success must be achieved in scaling up the size of the plant, and also in improving areas of technology. The status of developments along these lines is discussed. (auth)

29069 ECONOMIC ASPECTS OF NUCLEAR FRESH-WATER PRODUCTION. Buch, A. F. (Salzgitter Industriebau GmbH, Ger.). pp 435-45 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

An adequate world-wide supply of water and power is a problem of urgent concern. The demand for these two vital elements rises as a function of the increase in population and the standard of living. The annual ratios of increase for water and power are approximately the same, i.e., about 7.2%, corresponding to a doubling of the consumption within 10 years. No difficulties are envisaged concerning the increasing power demand since energy resources are still available, but the water supply becomes increasingly critical. Because of water shortage in densely populated and concentrated industrial areas it is frequently necessary to circulate the water eight to ten times, whereby it is not possible to avoid a deterioration of the water quality. To meet the water demand in areas that suffer from a shortage, the production of fresh-water from sea-water and brackish water is becoming increasingly important. All processes for producing fresh water from the sea are more or less expensive. To compensate for the high initial expenditures for evaporator plants, which are still the most suitable processes for water production, use is being made of a cheap energy carrier, involving attempts to apply nuclear energy. Compared with other energy carriers the calorie price for the latter referred to at 10^6 kcal, is at present DM 2.20 compared with pit coal at DM 10, oil at DM 8.50, natural gas at DM 8, and brown coal at DM 4.50. The high initial expenditure of a fresh-water production plant and the capital intensity of the evaporation process become more critical with that of a nuclear power station for which the fixed expenditure amounts to approximately 75% of the nuclear energy price. The water prices when steam is produced by nuclear energy and the limits of the economic applications for consumer groups of fresh and processed water and water for agricultural purposes are presented. In choosing a reactor that allows a high steam condition and has, thus, a great heat drop, the proceeds of the power produced in backpressure operation may considerably relieve the steam process and thus decrease the initial expenditure required for the production of fresh water. Since the competition of prices for fresh water and power must be judged differently, and since, as regards sales, power can be valued on the basis of the costs of the condensation plant operation, a further reduction of the water price results. This investigation not only covers the assessment of some serviceable types of reactors in connection with nuclear steam generation but also the economic possibilities for using conventional thermal power plants on the basis of different energy carriers. Graphs show water prices in relation to those of steam and power so that the degree of competition between the individual consumer groups of fresh and processed water as well as for water for agriculture may be deduced. 13 references. (auth)

29070 RECENT DEVELOPMENTS IN THE AGRO-INDUSTRIAL COMPLEX STUDIES AT OAK RIDGE NATIONAL LABORATORY. Michel, J. W.; Mrochek, J. E. (Oak Ridge National Lab., Tenn.). pp 585-604 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

An extension of the earlier work on agro-industrial complexes at Oak Ridge National Laboratory has been devoted, in part, to further optimization and sensitivity analyses, to a study of adding new enterprises to the complex, and to an examination of specific applications in various parts of the world. The relative advantage of the energy centre concept has been further examined and extended to include a smaller scale of operation which, in many cases, offers a more practical approach to actual implementation. The sensitivity analysis has examined the effects which changes in the many assumptions have on the overall economics of the agro-industrial complex. This includes changes in complex size, product mix, technology, price level, construction cost and schedule, start-up schedule, water-use efficiency, etc. These studies have helped to delineate the critical elements inherent in the design of such complexes. Several additional enterprises have been evaluated for inclusion in an energy centre. On the industrial side, these include the D-LM iron process, marine chemicals recovery and several heat-intensive processes. Building block data on a number of agricultural crops, not considered in the earlier study, have been developed, and studies on meat and milk production, food processing and aquaculture are being completed. More detailed studies of possible coastal desert locations have emphasized the importance of incorporating the many "site" factors, such as rainfall and the proximity to industrial raw materials, in determining the cost and benefit characteristics of such complexes. Preliminary work in the area of project financing and organization reveals the many alternatives available as well as the potential problems. (auth)

29071 PROJECT OF AN EXPERIMENTAL AGRICULTURAL STATION FOR DEMONSTRATION PURPOSES, IN COMBINATION WITH A DESALTING FACILITY. Fourcy, A. (CEA, Paris); Dutheil, Francoise; Damagnez, J. pp 605-18 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970). (In French).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

For an agro-industrial complex to be economic it is essential that the high cost of the water be offset by a maximum yield in terms of agricultural and food produce. It is not easy to obtain the maximum yield in agriculture without considering the local agronomic and human factors. It is suggested that, before embarking on ambitious projects in countries with limited resources, an experimental station should be established alongside multi-purpose desalting facilities. The station with a staff of ten research workers and the necessary technical personnel in an area of about four hectares should have the following functions: (a) adaptation of the known agronomic data to local conditions; (b) selection of appropriate crops and market research to determine the best production conditions, (c) commercial calculations on the basis of the actual yield obtained at the site; (d) training of specialized local personnel to relieve the initial staff. The layout of such a station is described, giving an outline balance sheet and programme of work, and the economic development potential of a facility of this type is discussed. (auth)

29072 INDUSTRIAL COMPLEXES BASED ON NUCLEAR DESALINATION WASTE BRINES. Yee, W. C. (Oak Ridge National Lab., Tenn.). pp 619-37 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

Waste brines discharged from dual-purpose nuclear desalination plants can form the basis for an industrial complex. The location of such plants in arid coastal desert areas implies an abundance of solar energy which can be used to separate out sequentially such primary products as gypsum, solar salt, potash and magnesium chloride by fractional crystallization. Secondary product production involves using electrical and steam energy from the dual-purpose plant to obtain sulphuric acid and cement from gypsum, caustic soda and chlorine from solar salt, and magnesium metal from magnesium chloride. Internally, caustic soda and chlorine (as hydrochloric acid) can be used to remove bicarbonate ion from sea-water before fresh-water production. Caustic soda and chlorine are also the basic chemicals for a whole array of tertiary products such as pulp and rayon from grain wastes of a nuclear-powered agro-industrial complex, and PVC plastics and chlorinated hydrocarbons when a source of petroleum is available. The economics of each process building block are

discussed in the order of their sensitivity to the cost of electric power. This is followed by several illustrations of industrial complexes based on these building blocks. 25 references. (auth)

29073 PEAK POWER SUPPLY FROM NUCLEAR ENERGY CENTRES. Halzl, J.; Szabo, Z.; Szuecs, L.; Torma, M. (Thermo Energy Design Office, Budapest). pp 653-70 of Nuclear Energy Costs and Economic Development. Vienna; International Atomic Energy Agency (1970).

From Symposium on Nuclear Energy Costs and Economic Development, Istanbul, Turkey. See STI/PUB-239; CONF-691020.

In recent years a new operational regime for conventional backpressure district-heating power plants has been developed and tested in Hungary, which uses the heat-storage capacity of the district-heating pipelines and the heated buildings to increase the electricity output of the power plant. The experiences gained with this method of peak-load operation are described, and it is shown that this method of peak-load operation has no harmful repercussions on the district heating lines or on the heat consumers. The combination of district heating with electricity generation also enables winter peak-load operation in a nuclear energy centre under favourable circumstances because such operation is possible without reducing the utilization of the reactor. To avoid radiation hazards residential areas should be sited at some distance from the power plant but the heat-storage capacity of the necessary additional pipeline would considerably increase the possibilities of peak power supply. The main factors influencing the selection of the main parameters of the nuclear energy centre and the district heating system connected to it are described, and the possibilities of peak-load operation and its expected economy considered. Examples are given to show that, in certain cases, favourable possibilities of economic peak power production exist in a nuclear energy centre, which make it possible to increase considerably the share of energy requirements that can, in the long run, be supplied by nuclear energy. (auth)

29074 PROCESS HEAT FROM NUCLEAR REACTORS. Block, F. R. (Technische Hochschule, Aachen). Chem.-Ing.-Tech.; 42: 429-33(Apr 1970). (In German).

Analysis of the energy consumption of the heavy chemical industry has shown that process heat is required primarily for the manufacture of carbon monoxide and hydrogen at relatively high temperatures (e.g., in blast furnaces at about 1000°C). As soon as thermal energy from nuclear reactors becomes cheaply available at sufficiently high temperatures it should find a ready market, e.g., in fossilized-fuel utilization, decomposition of water, the smelting industry, and the synthesis of ammonia and methanol. 5 references. (auth)

Marine and Portable Power Reactors

29075 (DOCKET-50238-60) N. S. SAVANNAH. Facility License No. NS-1. Technical Specifications Change No. 8. (Division of Reactor Licensing (AEC), Washington, D. C.). 28 May 1970. 6p. Dep. CFSTI.

For First Atomic Ship Transport, Inc., New York.

Methods for decay heat removal while in drydock are described. (D.C.C.)

29076 EUROPE'S FIRST NUCLEAR MERCHANT SHIP. NICKEL-CONTAINING STEELS AND ALLOYS IN VITAL REACTOR PARTS. Inco Nickel; No. 24, 1; 3(Apr 1969).

A review of nickel alloy steel reactor components used in the Otto Hahn Reactor is presented. (D.C.C.)

29077 OUTLINE OF ENGINES AND MACHINERY FOR FIRST NUCLEAR-POWER SHIP MUTSU. Egawa, Kiyoshi (Ishikawajima-Harima Heavy Industries Co., Tokyo). Nippon Zosen Gakkaishi; No. 484, 477-84(Oct 1969). (In Japanese).

The "Mutsu" was launched in June 1969 and will be completed in January 1972. Features of the nuclear-powered ship "Mutsu" are as follows: purpose, acquisition of building technique and operating experience for the nuclear-powered ship, crew training, and utilization as a special freighter; gross tonnage, 8350 t; cruising speed, 16.5 kt; crew members, 79; nuclear reactor, PWR with heat output 36 MW; main engine, marine saturated steam turbine; continuous max. power, 10,000 ps. Engines and machinery of the "Mutsu" are described on the following: main turbine, auxiliary boiler, low-pressure steam generator, moisture separator for saturated steam, main dumping system, decay-heat dumping system, quality of feed water, feed-water pumps, electricity generator, and operating conditions of the engines and machinery (NSA of Japan)

Production Reactors

29078 (BNWL-CC-702) EVALUATION OF AN ULTRASONIC METHOD FOR MEASURING REACTOR ALUMINUM PROCESS TUBE WALL THICKNESS. Hunter, D. O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 13 Jun 1966. Contract AT(45-1)-1830. 45p. Dep. CFSTI.

Pulse-echo ultrasonic inspection techniques for aluminum process tubes of Hanford Production Reactors are described. Results for in-reactor measurement of tube thickness variations are presented. 4 references. (D.C.C.)

Reactor Theory

Kinetics

Refer also to abstracts 28786, 28993, 28994, 28997-28999, 29001, and 29037.

29079 (AAEC/TM-532) FEW-GROUP CONDENSATION CALCULATIONS FOR LATTICE CELLS. Doherty, G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1970. 6p. Dep. CFSTI (U. S. Sales Only).

The procedure for condensing to few groups prior to the main transport calculation is described. The method is to perform a few region, many group, collision probability calculation to obtain condensing spectra appropriate to the different materials in the cell. Sample calculations for some natural uranium cells are reported. 8 references. (auth) (Australia)

29080 (AECL-3423) CALCULATIONS OF FLUX SPECTRA AND ENERGY DEPOSITION FOR FAST NEUTRONS. Mehta, K. K.; Kry, P. R. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Sep 1969. 120p. Dep. CFSTI (U. S. Sales Only). AECL $2.50.

A FORTRAN IV code NEVEMOR has been written utilizing a multigroup-multiregion method for calculating fast neutron flux spectra, neutron energy deposition, and foil activations due to fast neutrons in a heterogeneous lattice cell. Estimates are made of the effects of using group cross sections and of homogenization. Non-isotropic elastic scattering of neutrons off light nuclei (in the laboratory co-ordinate system) is considered by applying transport corrections in such cases. Inelastic scattering is handled by assuming that there is only one state to which the target nucleus could be excited, except for ^{238}U where detailed group-to-group cross sections are used. Values obtained with NEVEMOR for dose rates are compared with earlier measurements in the WR-1 reactor at low reactor powers. The agreement is within 5%. The contribution to the dose rates of the neighboring fuel cells is also calculated for WR-1. Results of experiments in the NRX and NRU reactors also agree well with the values calculated with NEVEMOR. 15 references. (auth)

29081 VERIFICATION OF SPACE-TIME REACTOR-KINETICS ANALYSIS BY EXPERIMENTS. Hassan, H. H.; Miley, G. H. (Univ. of Illinois, Urbana). Nucl. Sci. Eng.; 40: 449-59(Jun 1970).

Space-time nuclear reactor kinetic calculations based on the well-known computer program WIGLE are compared with measurements from neutron-pulse-propagation experiments. Transients were induced in a heavy-water-moderated, natural uranium subcritical assembly using a coupling extending through a graphite thermal column to a pulsed TRIGA reactor. Results are reported for five k_{eff} values ranging from 0 to 0.92, involving cases both with and without cadmium control rods inserted. A unit-cell-homogenization technique was adopted for analysis purposes, with special attention being given to proper parameter assignment, such as neutron velocity averaging. Calculation results compare favorably with experimental results for the interior of the assembly; however, differences as large as 7% are noted near interfaces or boundaries. (19 references) (auth)

29082 APPROXIMATE SOLUTION TO THE ASYMPTOTIC SLOWING DOWN EQUATIONS OF FAST NEUTRONS. Segev, M. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 40: 424-37(Jun 1970).

An approximate solution is proposed to the asymptotic slowing down equations in an infinite, homogenous, and weakly absorbing mixture of elements, in the energy range of fast-reactor neutrons. The relation is constructed to reduce to the approximate solutions both in the limit of purely elastic scattering and in the limit of inelastic scattering by infinitely heavy scatterers. The relation is shown to be an approximate solution also in inter-

mediate cases, where both target recoil and level excitation are important, provided that the mixture contains a substantial amount of medium-mass or light scatterers. Higher order terms may be included in the relation to better account for the effects of absorption. (10 references) (auth)

29083 NUMERICAL CALCULATION OF THE TIME-DEPENDENT NEUTRON SPECTRA IN A PULSED HOMOGENEOUS MULTIPLYING SYSTEM. Rodriguez, Pablo (Instituto Venezolano de Investigaciones Cientificas, Caracas); Nguyen, Dong H. Nucl. Sci. Eng.; 40: 488-91(Jun 1970).

29084 PROMPT-JUMP CORRECTION OF INVERSE KINETICS ROD-DROP MEASUREMENTS. Kussmaul, Guenter (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng.; 40: 494-8(Jun 1970).

29085 SEVERAL PARTICULAR SOLUTIONS OF THE ONE-SPEED TRANSPORT EQUATION. Oezisik, M. N.; Siewert, C. E. (North Carolina State Univ., Raleigh). Nucl. Sci. Eng.; 40: 491-4(Jun 1970).

29086 SPACE- AND TIME-DEPENDENT NEUTRON SLOWING DOWN. Diamond, David J.; Yip, Sidney (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng.; 40: 460-71(Jun 1970).

Analysis of space- and time-dependent slowing down is carried out using diffusion, P1, and B1 approximations for hydrogen and nonhydrogenous moderators. The scattering cross section is assumed to be constant, but the cross section at source neutron energy is allowed to have a different value. The calculations are primarily concerned with the first and second time moments of the flux distribution $\phi(r, v, t)$. The results are used to interpret the spatial variation of slowing down times. The characteristic behavior in the case of water is shown to arise from the considerably longer mean-free-path at the source energy (MeV). Time moments are also used to show that the transport approximation in P1 and B1 calculations for hydrogen can lead to a nonphysical result. Given the time moments, a simple procedure is proposed for obtaining $\phi(r, v, t)$. This approximation is found to be quite accurate when tested using diffusion theory moments. Comparison of theory and experiment is discussed in terms of recent measurements and Monte Carlo studies on water. So far as agreement with the available data is concerned, time-dependent diffusion theory calculations are found to be quite adequate. (auth)

Dynamics

29087 APPROXIMATE CALCULATION OF PROMPT-CRITICAL EXCURSIONS. Goldstein, Rubin; Shotkin, Louis M. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 40: 498-500(Jun 1970).

29088 IDENTIFICATION OF A NUCLEAR REACTOR CONTROL SYSTEM BY CROSS CORRELATION. Walker, P. A. W. (Liverpool Univ.); Ward, E. J.; Maudsley, D. J. Brit. Nucl. Energy Soc.; 9: 85-93(Apr 1970).

The use of the cross-correlation process for system identification is examined by using deterministic pseudo-random binary noise on a specially built reactor control loop. The effectiveness of the technique for determining the dynamic response of the reactor power level control system is evaluated by comparing practical correlation results from a digital correlator with measured transient step responses. Results illustrate the effectiveness of the method for identifying the impulse response of a closed loop reactor control system, without disturbing the power level deviation by more than 2 or 3%. (UK)

29089 ESTIMATION OF ASYMPTOTIC STABILITY DOMAIN OF THERMAL REACTOR WITH DISCRETE-TIME CONTROL. Ronzhin, O. B. At. Energ. (USSR); 28: 145-7(Feb 1970). (In Russian).

An attempt was made to evaluate permissible initial deflection variables from the stationary values in the region of the asymptotic stability and to determine its dimensions as a function of reactor parameters. The results showed that the magnitude ρ_p (asymptotic stability) does not depend on the control interval during variations within the limits of permissible values. In the region of real parameter values, the region of permissible initial deviations of xenon concentrations exceeded considerably the zone of the control linearity. (R.V.J.)

Experimental Applications

Refer also to abstracts 28992 and 29050.

29090 (BAW-10021) TEMP: THERMAL ENTHALPY MIXING PROGRAM. (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation Dept.). Apr 1970. 54p.

The TEMP program is designed to analyze the heat transfer and hydraulic characteristics of a square-pitch array of heated parallel rods. It is therefore useful in the design of reactor cores and in the analysis of bundle heat transfer data. TEMP considers the coolant and energy interchange between channels resulting from the turbulence of the fluid; it is thus an improvement over CHATA, which considered each channel to be isolated. (5 references) (auth)

29091 (KFKI-23/1969) THEORETICAL AND EXPERIMENTAL STUDIES OF TWO-REGION REACTOR. Mogil'ner, A. I.; Semenov, E. F.; Shvetsov, D. M.; Satmari, Z. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1969]. 20p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The behavior of a reactor with strongly differing regions, such as the core and the reflector, was studied by means of a theoretical model. The results obtained by A. E. Waltar and L. Ruby for determining the reactivity by using a pulsed neutron generator were found to be applicable for the case involving the injection of neutrons into the reflector. The position of the detector did not affect the value of the reactivity. The kinetics of 2-region reactors may be better understood by studying the difference between stationary and nonstationary flux, decomposing the neutron density drop into two exponential functions. 7 references. (TTT)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 27324, 27386, 27757, 27786, and 28983.

29092 (AE-390) USE OF FISSION PRODUCT ^{106}Ru GAMMA ACTIVITY AS A METHOD FOR ESTIMATING THE RELATIVE NUMBER OF FISSION EVENTS IN ^{235}U AND ^{239}Pu IN LOW-ENRICHED FUEL ELEMENTS. Forsyth, R. S.; Blackadder, W. H. (Aktiebolaget Atomenergi, Studsvik (Sweden)). [1970]. 26p. (CONF-700701-1). Dep. CFSTI (U. S. Sales Only).

For Presentation at IAEA Symposium on Progress in Safeguards Techniques, Karlsruhe, Germany.

The yields of ^{106}Ru for fission in ^{235}U and in ^{239}Pu are widely different (by about a factor of 12) while the fission yields for the other most abundant gamma-emitting fission products such as ^{137}Cs and ^{95}Zr are almost the same for ^{235}U and ^{239}Pu. Hence the relative gamma activities of these fission products represent a possible method for estimating the relative fission rates in ^{235}U and in the ^{239}Pu formed by neutron capture in the fuel. Measurements performed on a low-enriched UO_2 fuel rod from the Halden BWR, irradiated to a mean burnup of about 6600 MWD/t are described. They were made stepwise along the rod and compared later with a continuous gamma scan which gave the burnup profile. The gamma spectra were obtained by means of a high-resolution Ge(Li) detector which permitted satisfactory separation of the principal gamma photopeaks in the 400 to 900 keV energy range. The results, corrected for decay and self-absorption, were compared with the calculated ratios of the fission product activities at the same time. These were obtained by calculating the fraction of ^{239}Pu fission events as a function of burnup using the REBUS-2 programme, and from these figures calculating the growth and decay of the various fission products as a function of the irradiation history of the fuel, using the appropriate values for the fission yields. In spite of the very complicated irradiation history of the fuel, promising agreement was obtained, showing roughly the same scatter as results from destructive analysis of the fuel by the ^{235}U depletion and stable molybdenum isotopes methods. (auth) (Sweden)

29093 (AERE-Trans-1119) KINETICS OF FISSION-FRAGMENT YIELD FROM SINGLE-CRYSTAL UO_2. Samsonov, B. V.; Lyadov, G. D.; Frei, A. K. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). Translated by J. E. Baker (Atomic Energy Research Establishment, Harwell, Eng.), from preprint NIIAR-P-26. 13p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

The method of determination of fission fragment yield from the fuel is developed, and some experimental results on the diffusion coefficients of ^{132}Xe, ^{135}Xe, ^{136}Xe and ^{133}I, ^{135}I isotopes during thermal neutron irradiation are given. (auth) (UK)

29094 (AERE-Trans-1122) KINETICS OF FISSION-FRAGMENT YIELD DURING CHANGES OF REACTOR POWER. Samsonov, B. V.; Sidorov, V. V. (Scientific Research Atomic Reactor Inst.,

Melekess (USSR)). Translated by J. E. Baker (Atomic Energy Research Establishment, Harwell, Eng.), from preprint NIIAR-P-27, 12p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

The phenomenon of the activity burst of fission products emerging from the fuel composition at a sharp reactor power increase is investigated. This activity burst is explained by the changes of neutron flux, temperature and the diffusion coefficient of fragments. Calculations and experimental results are given. The calculated data are in agreement with experiments. (auth) (UK)

29095 (ORNL-4346) USE OF SMALL MODELS IN DESIGN AND ANALYSIS OF PRESTRESSED-CONCRETE REACTOR VESSELS. Corum, J. M.; Smith, J. E. (Oak Ridge National Lab., Tenn.). May 1970. Contract W-7405-eng-26. 279p. Dep. CFSTI.

A series of small prestressed-concrete reactor vessel (PCRV) models was designed, analyzed, constructed, and tested to investigate the suitability of small-scale (≤1/20) mortar models and epoxy models for determining elastic stress distributions and cracking and failure modes of concrete vessels, and to demonstrate the adequacy and relative accuracy of two- and three-dimensional elastic finite-element structural analyses when applied to relatively complex vessel shapes. Five models were studied. The first was a small concrete vessel that served as the prototype for the other four. There were two $\frac{1}{2.75}$-scale mortar models of the prototype; a $\frac{1}{3}$-scale prestressed epoxy model; and a $\frac{1}{3}$-scale, idealized, unprestressed, axisymmetric epoxy model. Each model was extensively instrumented, and the test results were compared with finite-element predictions. The prototype and the two mortar models were tested to failure with internal pressure. The prototype and one mortar model were pressurized hydraulically but, to examine possible differences in structural behavior, the other mortar model was tested pneumatically. The epoxy models were tested in the elastic range only. Results are presented. (53 references) (auth)

29096 A NUCLEAR REACTOR FUEL TUBE END CLOSURES. Whittaker, Stanley James; Watson, Robert Douglas; McManus, John Gerald (to Atomic Energy of Canada Ltd.). British Patent 1,187,905. 15 Apr 1970. Priority date 16 Oct 1967, Canada.

The design is given of an end closure for a nuclear fuel tube. The end closure opens in response to the loading operation of the fuel elements as they are placed into a pressure tube by a fueling machine and closes under high internal pressure and temperature of the pressure tube. The end closure is sealed to prevent leakage of the coolant from the pressure tubes. (J.C.W.)

29097 FUEL ASSEMBLY DESIGN AND FUEL HANDLING SYSTEM. Mattox, G. C. (Babcock and Wilcox, Lynchburg, Va.). Nucl. Eng. Int.; 15: 342-4(Apr 1970).

Fuel assemblies, which are the canless square lattice type containing low-enriched UO_2 pellets clad in Zircaloy-4, are described and some details are given of the tests carried out to verify and evaluate their design. There are also descriptions of the fuel handling and storage systems, and of the safety provisions designed into the fuel handling system. (UK)

29098 A PROCESS FOR ASSEMBLING A FUEL ELEMENT SUPPORT. Coudray, Roger (to Commissariat a l'Energie Atomique). British Patent 1,191,810. 13 May 1970. Priority date 3 May 1968, France.

A process for assembling a fuel element support inside an annular jacket is described. The support comprises an annular metal strut and a number of pin-like members distributed uniformly around the seat to form a stirrup in which the seat engages. The pin-like members are secured to the outer jacket and their central portions engage below an edge of the seat. Means is provided for tensioning the pin-like members, after which the edge of the seat is crimped over their center portions. (H.D.R.)

29099 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Pettinger, Donald Stanley (to Nuclear Power Group Ltd.). British Patent 1,189,381. 22 Apr 1970. Filed 3 Jan 1968.

The object is to provide in a cluster fuel element assembly an alternative or improved means for locking the individual fuel containing members against rotation about their longitudinal axes. The ends of these members are shaped so that for at least some of the pairs of adjoining end faces, a projection on one end face engages a recess in the other end face; the cross section of projection and recess is shaped so that each has at least one straight side, and the members are orientated so that a straight side on a projection faces a straight side of its associated recess. In one arrangement of this kind one end face of a pair of adjoining end faces has a projection in the shape of a minor segment of a circle and the recess on the end face of the adjoining member is of the same shape. In a further arrangement one end face of a pair of adjoining end faces has two projections on opposite sides of the member, and each projection has a cross section in the shape of a minor segment of a circle and adapted to engage recesses of corresponding shape in the end face of the adjoining member. (UK)

GENERAL

29100 (ANL-7660) C:REGN: A REENTRANT LINEAR AND QUADRATIC REGRESSION ROUTINE. Thalmayer, Conrad E. (Argonne National Lab., Ill.). Jan 1970. Contract W-31-109-eng-38. 27p. Dep. CFSTI.

29101 (ANL-7667) C:REGUSE: A LINEAR AND QUADRATIC REGRESSION USER PROGRAM. Thalmayer, Conrad E. (Argonne National Lab., Ill.). Feb 1970. Contract W-31-109-eng-38. 19p. Dep. CFSTI.

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High-fired boron nitride reacts with 6M H_2SO_4 and $KClO_4$ when the mixture is heated in a sealed glass tube for four hours at 350° C. The resulting ammonium-type nitrogen is contained in a clear solution that is suitable for analysis using a modified Kjeldahl apparatus. (auth)